MPHIL

A Framework for Learning
Typology and the Design Studio

Grover, Robert

Award date:
2016

Awarding institution:
University of Bath

A FRAMEWORK FOR LEARNING: TYPOLOGY AND THE DESIGN STUDIO

Robert John Grover

A FRAMEWORK FOR LEARNING: TYPOLOGY AND THE DESIGN STUDIO

Robert John Grover

A thesis submitted for the degree of Master of Philosophy

University of Bath
Department of Architecture and Civil Engineering
October 2016

Robert Grover

ACKNOWLEDGEMENTS

This thesis is submitted for fulfillment of the requirements for the degree of Master of Philosophy (MPhil) at the University of Bath. I am thankful to Professor Stephen Emmitt and Dr. Alex Copping who have supervised me in this endeavor and their help and guidance has been gratefully received. I also owe thanks to Mark Wilson Jones who offered supervision in the early stages of the research.

I am grateful to the University of Bath and the Department of Architecture and Civil Engineering as well as the staff and students who have contributed to, or supported, the thesis.

ABSTRACT

In the architectural design process, built precedent can be a valuable resource to shape design situations. Typology, the systematic categorisation of precedent, can act as a means to interpret this information and identify relationships between existing buildings and new design. This thesis explores the link between typology and the design process and asks how typological thinking may benefit novice designers in the context of the architectural design studio.

The research conceptually synthesises theories of typology with design methods to provide a practical framework for the application of typology in design studio teaching. Adopting a stage-based model of design, underpinned by the Critical Method as a description of individual design cycles, the framework offers a means of guiding project decisions, encouraging ideation and accessing information embedded in design precedents.

The research is exploratory in nature and adopts a mixed methodology approach to develop and test the proposed framework. An experimental study examines the role of typology in design heuristics whilst participant observation is used to develop and refine the typological framework. This is supported by data gathered from case studies, individual feedback, structured interviews and questionnaires.

The typological learning framework is supported by the results of the research and considers various interpretations of typology at each stage in the design process, analytical processes required and practical guidance for designers and educators.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1.0 INTRODUCTION

This thesis explores the link between architectural typology, as a means to interpret precedent, and the design process and proposes a structured framework for integration. This was developed through a theoretical synthesis of historical interpretations of typology with stage-based interpretations of design methods to provide a strategic outline for the practical use of precedents in the design studio. The thesis argues that typology may be used as a tool to shape individual heuristic processes and may play an active part in corroborating or rejecting proposals the design process.

Personal Biography and Motivation

My career as an architect, academic, student and tutor has had a profound influence on the subjects and issues addressed in the research. I began my architectural studies at the University of Bath in 2004, where I completed the Royal Institute of British Architects' (RIBA) Part 1. The course was characterised by its strong design studio culture, emphasis on project based, independent learning, and integration of technical subjects. The BSc programme was underpinned by the implicit implementation of the Critical Method, inherited from former teachers at the school including Ken Smithies and Michael Brawne and advocated by Alex Wright. The '*thin-sandwich*' structure meant two industrial placements were undertaken throughout the four years of study, one of which I spent at the University's Centre for Advanced Studies in Architecture (CASA), which developed my appreciation of architectural history.

Upon completing my RIBA Part 2 studies at London Metropolitan University, I spent a year working with Florian Beigel and Philip Christou of the Architecture Research Unit (ARU) and became increasingly concerned with the use of precedent to inform design, and the mechanisms through which eclectic architectural experience can be translated to inform current design practice.

Upon returning to Bath in 2012, I spent time in architectural practice (most significantly at Feilden Clegg Bradley Studios) as well as teaching first year and final year undergraduate design studio at the University of Bath. My primary motivation for the research has stemmed from these experiences. Observed inconsistencies in the analysis architectural precedent to effectively extract

design information fuelled a desire to develop greater understanding about the role that it plays in the design process.

Motivation also came from a want to address the perceived void between technical aspects of architectural education, in this case studies in history and theory, and the design studio. I was surprised at the lack of knowledge integration observed in the design studio and was keen to ask how these apparently disparate elements may be made more cohesive.

Context of the Research

The research takes place within the context of the architectural design studio amongst undergraduate first year students at the University of Bath. The studio remains the primary pedagogy of architectural education in the UK (McClean, 2009) and dominates both as a physical and symbolic environment where students are expected to conduct most of their learning (Anderson, 2013). It is founded on the ideological principles of social learning, independent reflection and practical skills acquisition (Schön, 1985). The studio owes its origins to the apprenticeship system employed by medieval guilds as well as to the Ecole des Beaux-Arts in the early 19th Century (Schön, 1985) and has proved an effective method for architectural education over the last fifty years.

Despite its ubiquity, there is little agreement on what actually constitutes the design studio. It is simultaneously a physical space, a method of teaching and a description of part of the curriculum. Moreover, its implementation varies between schools. This is acknowledged by McClean (2009) however he asserts that there remains common ideological strands that pervade the studio:

'Whilst the broad template of architecture education tends to be ubiquitous, it is important to acknowledge … that the pedagogies within are not singular, with different types of studio possessing different emphases and adopting a range of different yet related pedagogical approaches. Nevertheless, the common desire to achieve a seamless integration between theory and practice embeds the design studio, as the setting for creativity and synthesis, at the heart of the educational process' (p. 34)

The curriculum at the University of Bath consists predominantly of studio learning supplemented by formal teaching in more technical aspects of design. In the design studio, students share a space in which they individually and

simultaneously conduct similar or identical design projects set by the head of the year. The students are supported by tutors; usually practicing architects who teach part time. They have roughly one hour a week of contact time with their tutor generally in a one-to-one tutorial throughout the course of each design project. The projects mimic real design scenarios that may be encountered in practice yet without many of the limitations or the level of development that might be expected in practice.

The University of Bath and The Critical Method

The University of Bath curriculum has developed over the past fifty years, based on the work of a number of former prominent educators notably Smithies (1981) and Brawne (2003). The course in architecture at the University of Bath began in 1959, then housed in the Bristol technical College (Wilkinson, 2016). As Wilkinson (2016) notes, '*because the principal architectural staff were practicing architects they believed that the structural and service elements of buildings needed to be taught by professionals in those disciplines'*. This lead to the course in Building Technology which acted as a vehicle for combined education for architects and engineers who began to share lectures and work together on design projects. Moreover, both degrees had considerable periods of industrial training and focused on a practical education through project work.

Ken Smithies was one of the original members of staff of the school under the original head Ken Panter (Wilkinson, 2016) and introduced his spiraling model of the design process to the design studio in the mid 1960s. His influence is still felt today within the school and students are taught to understand his simple model of architectural design. Smithies' model implies a *conjecture – analysis* approach whereby an initial tentative solution is modified and analysed with regards to various aspects specific to the project brief gradually becoming more refined and undergoing the iterative cycle again. Moreover, the spiral model moves centrally towards a notional ideal solution yet never reaches it.

The Critical Method (CM) underpins the current ethos of the undergraduate degree, a philosophy based on the critical rationalism of Popper (1963), applied to design by Darke (1979), Smithies (1981) and Brawne (2003), and explicitly described by Wright (2011) at the University of Bath. According to Wright, the explicit use of CM as a pedagogic model was first introduced to the Department of Architecture and Civil Engineering undergraduate and postgraduate design studio models in 2005. At this time, both permanent staff and visiting tutors

were exposed to the method and expected to implement it in their teaching practice.

At the University of Bath, CM is understood as set of aspirational values, rather than a strict procedural model. Wright (2011) suggests appropriate criticism is the *'essential component'* in design development and emphasizes the objective analysis of students' work as key to the success of CM seeking to encourage both a productive and non-hostile studio environment. Whilst this may encourage positive cultural changes, the lack of rigourous implementation of CM means its efficacy as a structuring pedagogy is unclear. Moreover, its implementation is left to individual members of staff, many of whom teach only part time, providing little assurance that the method is adopted on a day to day basis. Whilst the strategic direction of the school and its overarching curriculum may embrace this Popperian epistemology, it remains unclear whether this is replicated at a tutor or student level.

Since the introduction of CM, it has been explicitly taught to undergraduate students of architecture who are made aware of its role in the design studio. Exposing students to a design model can have '*a profound and beneficial effect*' (Wilkinson, 2016) by suggesting a framework which may be used to structure ideation.

Collaborative design still also forms a corner stone of the educational model employed. Initially, architects are jointly educated with Civil Engineers and undergo a number of combined projects throughout their undergraduate education. Each year contains approximately 100 architecture and 100 civil engineering students from which groups are formed. This collaboration encourages an understanding of design which is both practical and legible, requiring the need for communication of design ideas to those beyond the architectural community.

The design studio at the University of Bath shares many similarities with that described by Schön (1985) and has indeed changed little throughout modern architectural education. Perhaps unique to the University, however, is the explicit endorsement of a model of design, in this case the Critical Method, and the consistent strategic approach across all degree levels. The research uses this environment as an abstraction and simplification of the architectural design process to explore the notion of typology.

1.1 Summary of the Literature Review

The nature of problems architects are faced with is dependent on a multiplicity of factors. Historically, the term *architect* has been used to define various roles including master-builder, craftsman, designer, strategic planner, project facilitator or information manager. Establishing consistent processes and methods is challenging and varies according to context, time and place. Even when considering only design, '*that is the intellectual activity that produces material artefacts'* (Simon, 1969, p. 111), there is little consensus on how architects operate.

Considering design as a problem to be solved was advocated in Herbert Simon's seminal book *The Science of Design* (1969). In part, this gave to rise to various theories on design methodology whereby design was considered to follow a rational process of analysis of the problem followed by synthesis of results.

Work by Rittel and Webber (1973) suggested that the problems designers face are *wicked*, that is the desired outcome is undefined, the processes to produce solutions are unclear and it is not apparent when a successful solution has been achieved. The theory suggests traditional problem solving methods are untenable and gave rise to various interpretations of how designers construct *design situations* (Roozenburg and Eekels, 1995, Dorst, 2011).

Alternatives to the problem solving model such as reflective practice (Schön, 1985), hermeneutic models (Hillier et al., 1972, Darke, 1979, Bamford, 2002) and participatory approaches (Cross, 1972) describe heuristic methods that designers adopt to deal with this complexity.

The Critical Method (CM) is one means of describing the heuristic processes of the designer and shares most in common with hermeneutic models which are concerned with understanding, interpretation, preconceptions and personal experience (Lie, 2011). Its development is based on Karl Popper's Theory of Critical Rationalism (1963) and it describes the design process in terms of an initial conjecture (a postulated attempt at a solution) followed by a critical analysis of that solution (Wright, 2011, Brawne, 2003, Darke, 1979). Through a cyclical process the project space gradually takes on greater definition.

CM in architectural design relies on the ability to both conjecture possible solutions and analyse their success. A key tenet of Popper's Critical Rationalism is falsifiability allowing potential solutions to be rejected in favour of more appropriate ones. In the scientific method, falsifiability can be achieved through the observation of real-world phenomenon, to test inductively derived theories (Brawne, 2003). Designers however, are often faced with an unbounded problem space lacking clearly defined goals and means of analysis. Designers are required to shape their own project space and utilise primary generators (Darke, 1979) or architectural concepts (Leupen, 2002); a central idea or theme upon which the project is hung. Novice designers often resort to abstract or deterministic ideas to provide a conceptual framework for the project (Wright, 2011).

Precedent may offer both a means to pre-structure design situations, shape primary generators, form conjectures and analyse possible solutions. Typology, the systematic study of types, is one means of interpreting precedent and extracting general design information for this purpose. By categorising precedents into types, structured by an overarching typology, common characteristics can be identified and the range of application examined. Moreover, reference to a particular type may provide novice designers with the means to associate with historical works of architecture, either for practical or symbolic purposes.

CM describes heuristic processes of the designer yet gives few clues to how this process adapts over the course of a design project. Various stage-based models of design have attempted to tackle this (Asimow, 1962, Watts, 1966, Smithies, 1981) and the RIBA's Plan of Work (2013) is a widely used framework of the design process in the UK. Curry (2014) suggests that design methodologies may be a pedagogic tool using them to facilitate heuristic processes depending on the experience of the designer. Stage-based models of design may offer a strategic framework to shape the heuristic processes of CM and help guide novice architects.

In a stage-based model of the design process, different notions of typology may be appropriate at different points. A common characteristic of the models is the movement from conceptual ideas to concrete reality and this suggests different design information, embedded in precedent, may be applicable at different points. Typological categorisation may be mapped to the various stages to provide a framework for heuristics throughout design.

In the proposed model, the term typology does not necessarily refer to predefined categorisations but may be generated by the designer in the formulation of the project space. The main characteristic of the self-defined typological system is that it allows comparison with other architectural work and for the project to be understood in the context of a wider architectural narrative.

1.2 Structure of the Research

The research is structured into 9 chapters:

- Chapter 1 introduces the notion of typology and design methods and sets out the aim and objectives of the research.
- Chapter 2 provides a broad overview of design methods literature and critically discusses them in the context of the design studio.
- Chapter 3 considers the historical role of typology and discusses its various interpretations. It also provides a synthesis between theories of type, the Critical Method and a stage-based model of the design process.
- Chapter 4 gives an overview of the methods to achieve the stated objectives.
- Chapter 5 describes the first phase of the research. It presents a quasi-experimental study into the role of typology in the Critical Method, exploring its role as both a means to generate conjecture and to analyse solutions.
- Chapter 6 describes the second phase of the research exploring a stage-based framework for the integration of typology into the design studio. Through an active participation approach the successes and limitations of the framework are addressed.
- Chapter 7 presents the findings of the third phase of the research. A comparative questionnaire is given to novice designers who were exposed to the typological framework and those who had not.
- Chapter 8 provides a discussion of the results through a triangulation of the three research phases in relation to the original objectives. It also presents a framework for typological learning.
- Chapter 9 concludes the research and provides recommendations for further study.

1.3 Aim and Objectives of the Research

The research is an exploratory study into the role of typology in the design studio. It aims to understand how precedents can be interpreted typologically to enhance the design process of novice designers. The research seeks to conceptually synthesise theories of typology with a stage based model of the design process to provide a practical framework for the application of typology in design studio teaching. The framework is underpinned by the Critical Method as a description of individual heuristic cycles and seeks to provide a means to guide project decisions, encourage ideation and provide methods of accessing information embedded in design precedents.

Objectives

Based on the stated aim, the research has the following stated objectives:

1. To examine the effect of the introduction of typologies on heuristic processes and the conjecture and analysis phases of the Critical Method
2. To develop a strategic, stage-based pedagogic model for the introduction of typology into the design process
3. To assess the value of the established pedagogic model in the studio environment

2.0 LITERATURE REVIEW OF DESIGN METHODS

The study of design methods as an independent discipline began after World War II when *'the development of professional knowledge in the form of theories, textbooks and exemplars of best practice, [became] regarded as a scientific project'* (Lie, 2011). Challenged by the complex nature of the issues that designers are faced with, various competing narratives arose to describe and structure operational processes. Beginning with a consideration of design problems, this chapter investigates various conceptual models of design.

2.1 Design Problems

2.1.1 Types of Design Problems

The often poor definition of design problems in the architecture has been highlighted by Cross (1982) and Fang (1993). Rowe (1987), places emphasis on the particular types of problems designers actually face, dividing them into either well-defined or ill-defined, the latter not solvable through conventional problem solving techniques and requiring *'design thinking'*.

Dorst (2011) describes the nature of design situations in the language of formal logic building on the work of Roozenburg and Eekels (1995). To Dorst, human reasoning methods can be understood in terms of the equation:

WHAT (the thing) + HOW (its working principle) = RESULT (observation)
(Dorst, 2011', p. 523)

Settings of the equation, where different variables are known at the outside, can be used to describe rational processes. In deduction, for example, the WHAT and the HOW are known at the outset allowing the prediction of a particular result. In induction, however, the thing itself is observed however its working method is unknown and must be conjectured. Attempts are then made to falsify this hypothesis.

Tomiyama et al. (2003), represent this equation in the language of formal logic where 'WHAT' can be understood as a set of facts (*F*), 'HOW' is a set of general axioms (*A*) and 'RESULT' is a specific theorem (*Th*). σ is the reasoning rule that allows derivation of the theorem. Accordingly:

$A \cup F \vdash_{\sigma} Th$

A specific theorem is the domain created in the union between general principles and set of facts or observations. In deduction, specific theorems are derived from general rules and observable facts (*Th* is unknown). Dorst (2011) uses the example of astronomy in which observable facts are represented by the stars and the science astronomy and physics provides a set of general rules which govern their movement. Using these general principles, a deductive process can be used to predict their observed movement. In induction, specific instances and observable facts are used to infer general rules or axioms (A is unknown). In the case of astronomy, specific observations take the place of predicted theorems to derive general principles (*A*). The scientific process is thus both inductive and deductive; the former used to establish axioms and the latter used to test these axioms through observation.

Dorst (2011) asserts that this equation can be applied to design and used to describe the nature of problems through a process of abduction. In abduction, specific theorems and general axioms are known at the outset generating a set of possible facts. As the factual domain is larger than that of specific theorems, there are potentially multiple possible outcomes that may satisfy the requirements of the result.

In Dorst's model, specific theories (*Th*) are understood as a values or aspirations (*V*), axioms as general design principles (*A*) and facts as the object of design (*F*). The equation is then re-written as:

$A \cup F \mid\!\sim_{\sigma} V$

Building on this logical epistemology, a further development of Dorst's abductive process can be proposed that describes the nature of design situations in relation to existing definitions of design problems. Rowe's (1987), taxonomy of design problems into *well-defined*, *ill-defined* and *wicked* problems can be reframed in the context of logical construction.

Well-Defined Problems

Well-defined problems, or tame problems (Rittel and Webber, 1973), can be understood as having a clear prescribed goal and the means of reaching that goal is clear. Examples offered by Coyne (2005) and Rowe (1987) include solving a quadratic equation, traversing a maze or crossword puzzles.

If a project is well-defined, axioms and values are known and when expressed in the format A∪F|-σV only *F* remains to be found. A simple example might be an engineer designing a beam where the aspired value (*V*) is known (i.e. the span of the beam), its governing principles are understood (*A*) (Newtonian physics and material science) however the exact nature of the beam (*F*) (its size, material etc) is yet to be established. Moreover, there is a clearly defined working principle (σ) to guide the designer to satisfactory outcome. An abductive reasoning mode is used to obtain a satisfactory result to be verified or falsified against desired aspirational values.

Rowe asserts that in architecture this may manifest itself as basic space planning problems *'in which a set of building spaces is prescribed, together with a site in which they are to be assembled and some expression of adjacency requirements among the spaces'* (1987). In this example, the value (*V*) is understood as the need to create a functional series of spaces, axioms (*A*) are in the form of general principles such as the constraints of the site and the relationship between spaces, and *F* could be understood to be an arrangement that satisfies *V* whilst conforming to the imposed principles. The designer is able to employ a series of accepted working methods (σ) such as diagrams, sketches and scales drawings to approach the challenge. As Rowe (1987) notes, the problem has sufficient clarity however it may have undergone significant research and redefinition before reaching this tame state.

Ill-Defined Problems

In design situations, however, general axioms may be unclear at the outset. Acknowledged principles are often subjective, debatable and contentious and two variables, (both the object (*F*) and the domain of axioms (*A*)) are unknown in their entirety, a problem could be considered *ill-defined* (Newell et al., 1959).

An example might be the design of a simple household item such as a refrigerator as offered by Suh (1990) and Tomiyama et al. (2003). In this case the specific outcome is understood as series of requirements such as the abilities to store, access and cool food. These may be broken down into further requirements however it becomes quite straightforward to generate an exhaustive list. Despite this, the problem remains ill-defined. There may be any number of innovative methods of cooling food as well as methods of storage and options for accessibility; the principles governing the design (*A*) are

mutable. The basic process of abduction cannot be applied as both the factual (*F*) and the axiomatic domains must be developed in parallel. This could be described as *design reasoning* (Dorst, 2011).

Wicked Problems

Commonly in architecture, neither *V, F* or *A* are fully defined at the outset. More often than not the aspired value is ill determined and changeable and often only becomes apparent throughout the design process. As the design situation takes shape opportunities become apparent that may alter the aspirational value of the project. Moreover, architectural projects are inevitably subject to conflicting values of various stakeholders, not least the architect themselves, which make its specific identification an impossibility. Dorst (2011) claims that in design problems, the end value is known at the outset but as Rittel (1972) has argued, in planning problems *'there are many clients and decision makers with conflicting values, and where the ramifications in the whole system are thoroughly confusing'*.

Such problems could be considered *wicked problems* (Churchman, 1967, Rittel and Webber, 1973, Bazjanac, 1974, Rowe, 1987, Buchanan, 1992). Rittel and Webber (1973) provide ten points that define *wicked problems* regarding urban planners:

- There is no definitive formulation of a wicked problem
- Wicked problems have no stopping rule
- Solutions to wicked problems are not true-or-false but good-or-bad
- There is no immediate or ultimate test of a solution to a wicked problem
- Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial and error, every attempt counts significantly
- Wicked problems do not have enumerable or exhaustively describable set of potential solutions, nor is there a well described set of permissible operations that may be incorporated into the plan
- Every wicked problem is essentially unique
- Every wicked problem can be considered to be a symptom of another problem
- The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution

- The planner has no right to be wrong

Adapted from Rittel and Webber (1973)

Reframing Rittel and Webber's check-list in the terms of the logical paradigm A∪F|-σV, none of the variables has full definition. Developing them in parallel therefore requires a specific mode of thought distinct from abduction, deduction or induction.

This *wickedness*, according to Buchanan (1992), comes about because design itself has no subject matter of its own: *'in the process of application the designer must discover or invent a particular subject out of the problems and issues of specific circumstances'* (p.16). The universality of design gives rise to this need for invention, and the necessity for the designer to set boundaries and as Buchanan (1992) suggests: *'the designer must discover a particular subject out of the problems and issues of specific circumstances. This sharply contrasts with the disciplines of science, which are concerned with understanding the principles, laws, rules, or structures that are necessarily embodied in existing subject matter'* (Buchanan, 1992', p. 16)

2.2 Design Methods

The study of Design Methods emerged in the 1960s with the aim of developing scientific methods that could be applied universally to design (Casakin, 2004). Various models proposed normative taxonomies of actions that could be applied to architecture. Such studies overlapped with developments in Artificial Intelligence and in the automation and replication of processes.

General System Theory underpinned much of this work. According to Bertalanffy (1950) *'the analysis of general system principles shows that many concepts which have often been considered anthropomorphic, metaphysical or vitalistic, are accessible to exact formulation'* (p. 163). The implication that processes, previously understood to be irrational, could be modelled as rational systems is an attractive one in the field of design where operations are often appear mysterious and unstructured.

Early normative models (Simon, 1969, Meadows et al., 1974) structured design as a rule based, goal orientated activity (Coyne, 2005), classifying it as a problem solving activity. Accordingly, more recent theories have interpreted the

process of design as a rich, varied and multifaceted activity drawing from fields of education, psychology, science amongst others (Dorst, 2011).

As Wright (2011) notes: *'The process by which designs are generated appears ill-defined and quasi- mysterious. Students, when faced with a problem and a blank sheet of paper, are offered little in terms of ways to generate design solutions.'* (p. 114). According to Simon (1969) designerly thinking involves: *'satisficing rather than optimising; producing any one of what might well be a large range of satisfactory solutions rather than attempting to generate the one hypothetically-optimum solution.'* (Cross, 1982)

2.2.1 Framing Design

Considering design as a purely problem solving activity is challenging when faced with *wicked* problems and research in design methods has invariably involved restructuring the notion of the design problem either through a process of reduction or conceptual expansion. Hatchuel (2001) suggests that whilst problem-solving is an integral to design, the process involves a number of other activities. The unbounded rationality of the initial problem requires a conceptual expansion by the designer; '*problems'* become '*projects'* which are neither fixed nor solvable (Dorst, 2006). Learning devices are also employed '*to learn about what has to be learned or could be learned: a drawing, a mock-up, a prototype, a scientific experimental-model, and a rehearsal are usual "learning-devices.""* (Hatchuel, 2001, p. 266). Moreover, design itself is a social activity, whereby social interactions become *'both a resource and a designable area'* (p. 267). Operating in an unbounded conceptual reality, social interaction operates as a value forming exercise governing the design and what can be formed.

Dorst (2006) outlines an alternative conceptual framework whereby the *design situation* becomes the unit of description rather than the *design problem*. Dorst suggests that design consists of satisfying series of paradoxical discourses; conflicting demands each with their own domain of knowledge. In the design situation, the designer must step outside the embodied thinking associated within each domain to satisfy the paradox. According to Dorst, '*based upon a clear understanding of the discourses, and upon earlier experiences with paradoxical situations, a solution is created that needs to be evaluated from the standpoints of all the different discourses*' (p.15). By setting aside the notion of

the problem, designers are able to move outside of traditional problem solving activities and embrace new frames of reference.

Maher and Poon (1996) propose a model of co-evolution whereby the problem space takes on definition simultaneously with the solution space. Dorst and Cross (2001) analyses of designers' processes describes the creative act of design as happening at the moment when the problem and solution spaces are linked. The linking of problem and solution spaces and constructing a design situation may be considered *design framing* (Schön, 1984) influenced by Goffman's (1974) text '*Frame analysis: an essay on the organisation of social experience*'. Frames may be defined cognitively by the designer's cognitive map, or as the product of 'social symbolic structures' (Paton and Dorst, 2011', p. 574).

Dorst (2011) suggests a *frame* is *'the general implication that by applying a certain working principle we will create a specific value'* (p.524) and applies this notion to the logical framework discussed in chapter 2.1. Dorst's description of framing requires the knowledge of a desired value, thus that the frame may be developed through an inductive process. Once a promising position is established, an abductive process seeks to determine possible solutions to achieve this requirement.

The reflective practice of Schön (1984) provides a cognitive theory of framing in the context of design:

'The very invention of a move or hypothesis depends on a normative framing of the situation, a setting of some problems to be solved. In the evaluation of a move, the designer asks whether he gets what he intends and whether, on the whole, he likes what he gets.' (p.132)

For Schön, this *normative framing* relies on *knowing-in-action* acquired through *'training or on the job experience'* and is usually *'tacit and delivered spontaneously'* (1985, p.24). This knowledge is dynamic and through reflection, a conscious dialogue between the actor and the situation, this *knowing-in-action* is translated to explicit *knowledge-for-action*.

As Paton and Dorst (2011) assert, however, Schon's view fails to recognise the inherent subjectivities embedded in frames. The frame is a cognitive structure developed by the designer and its modification through their reflective action.

In Paton and Dorst's model, client and architect each frame the problem; the client's frame is shaped by their understanding of the problem; the architect's frame by their professional knowledge and experience. In this scenario, the client's frame is reshaped by the architect's *primary-generators*, a set of conceptual ideas, (Darke, 1984) in the briefing process. The client's problem space is re-framed, simplifying the task whilst evoking possible problem outcomes (Paton and Dorst, 2011).

As Rittel and Webber (1973) assert, wicked problems are unable to be tested immediately thus it remains unclear whether the proposed solution may achieve the desired values. Without a means of testing solutions, there is no way of judging the appropriateness of the framing device. Moreover, wicked problems are subject to multiple and often conflicting values (Rittel, 1972), thus shaping a design situation into an attempt to achieve a clear desired value is not possible.

2.2.2 Classifying Design Methods

The literature on Design Methods is invariably concerned with framing design and placing design activities in the context of conceptual models of the design process. Reviews of the literature on design methodology are presented by Lie (2011) and Johansson-Sköldberg et al. (2013) among others. Johansson-Sköldberg et al. (2013) identify two distinct discourses, that of *'designerly thinking'* and that of *'design thinking'* where the former refers to the characterisation of the activities performed by designers whilst the latter refers to the application of these techniques beyond the context of design. Within the design thinking discourse they identify five key theoretical standpoints:

1. Design and designerly thinking as the creation of artefacts (Simon, 1969)
2. Design and designerly thinking as a reflexive practice (Schön, 1985)
3. Design and designerly thinking as a problem-solving activity (Buchanan, 1992)
4. Design and designerly thinking as a way of reasoning/making sense of things (Lawson, 2006, Cross, 2007)
5. Design and designerly thinking as creation of meaning (Krippendorff and Butter, 2007)

Adapted from Johansson-Sköldberg et al. (2013', p. 124)

Similarly, Lie (2011), frames designerly thinking in six models of *'professional reasoning'*:

1. Problem solving models e.g. Simon (1969) and (Newell et al., 1958)
2. Reflexive practice models e.g. Schön (1985)
3. Doctrinaire models e.g. Vitruvius (1960)
4. Hermeneutic models e.g. Bamford (1991) and Coyne and Snodgrass (1995)
5. Social Models e.g. Vincenti (1990)
6. Participatory models e.g. Cross (1972) Sanoff (2007)

Adapted from Lie (2011)

More recently Curry (2014) identified three broad categories of methodologies: design as problem solving (procedural methods); design as learning (iterative process); design as evolution (characterised by a moment of inspiration following incubation).

A further distinction of design models is made by Evbuomwan et al. (1996) with regards to models of the design process in engineering. A separation is made between models that consider design staged based consisting of a series of procedural steps, and those which consider the actual activities of design (analysis, synthesis, evaluation etc).

The literature regarding design methods may be organised into two broad paradigms; procedural and heuristic. These are outlined in table 2.1 and will be discussed in greater detail later in the chapter.

Design Methods Paradigm	**Model**	**Characteristics**	**Examples**
Procedural (Design as a problem solving activity)	Doctrinaire	Design process defined by rules, set protoypes or autonomous methodologies.	Vitruvius (Rowland and Howe, 2001) Durand (1809)
	Stage-Based	Whole design process divided into discrete phases.	Asimow (1962) Smithies (1981) Pahl et al. (2007) Watts (1966) Hubka and Eder (2012) French (1985) Royal Institute of British Architects (2013)
	Activity based	Designer's activities described as discrete steps	Newell et al. (1958) Marples (1961)

		following an analysis of a problem to a synthesis of a solution.	Thornley (1962) Archer (1964) Krick (1965) Simon (1969) Harris (1980) Roozenburg and Cross (1991)
Heuristic (Design as an interpretive and iterative activity)	Reflective practice	Iterative interpretation of design based on the designer's reflection in action.	Schön (1985)
	Hermeneutic activity	Designer's activities described as a process of personal conjecture followed by objective analysis. Focus on the creation of meaning and acknowledging preconceptions.	Hillier et al. (1972) Darke (1979) Bamford (2002) Brawne (2003) Wright (2011)

Table 2.1: Paradigms in Design Methods

2.2.3 Procedural Models of Design

Models of rational design describe the design process as a as *'a goal-oriented, tractable process, moulded in the tradition of decision-theory and systems theory'* (Lie, 2011, p.77). This approach is described by Herbert Simon in *The sciences of the artificial* (1969). A fundamental aspect is the separation of activities of creation from activities that deal with existing nature. The design process can therefore be conceived as a rational construct that *'transforms existing conditions into preferred ones'* (Simon, 1996, p.4).

Simon (1977) asserts that there is a fluid boundary between problem types. For Simon, even the most wicked of problems can be broken down into smaller solvable parts, which together give structure to the large scale problem. This reduction represents a reframing of the design situation to a purely rational construction in which the initial problem itself gradually takes on definition tending towards a solution.

Doctrinaire Models

Doctrinaire approaches to design as identified by Lie (2011) involve the adoption of categorical systems that guide the design process. Approaches generally involve the adoption of predefined prototypes, rule systems or methodologies which reduce the autonomy of the designer. Examples include

Vitruvius' *Ten Books on Architecture* (Rowland and Howe, 2001) and Durand's *Précis of the lectures on architecture* (1809).

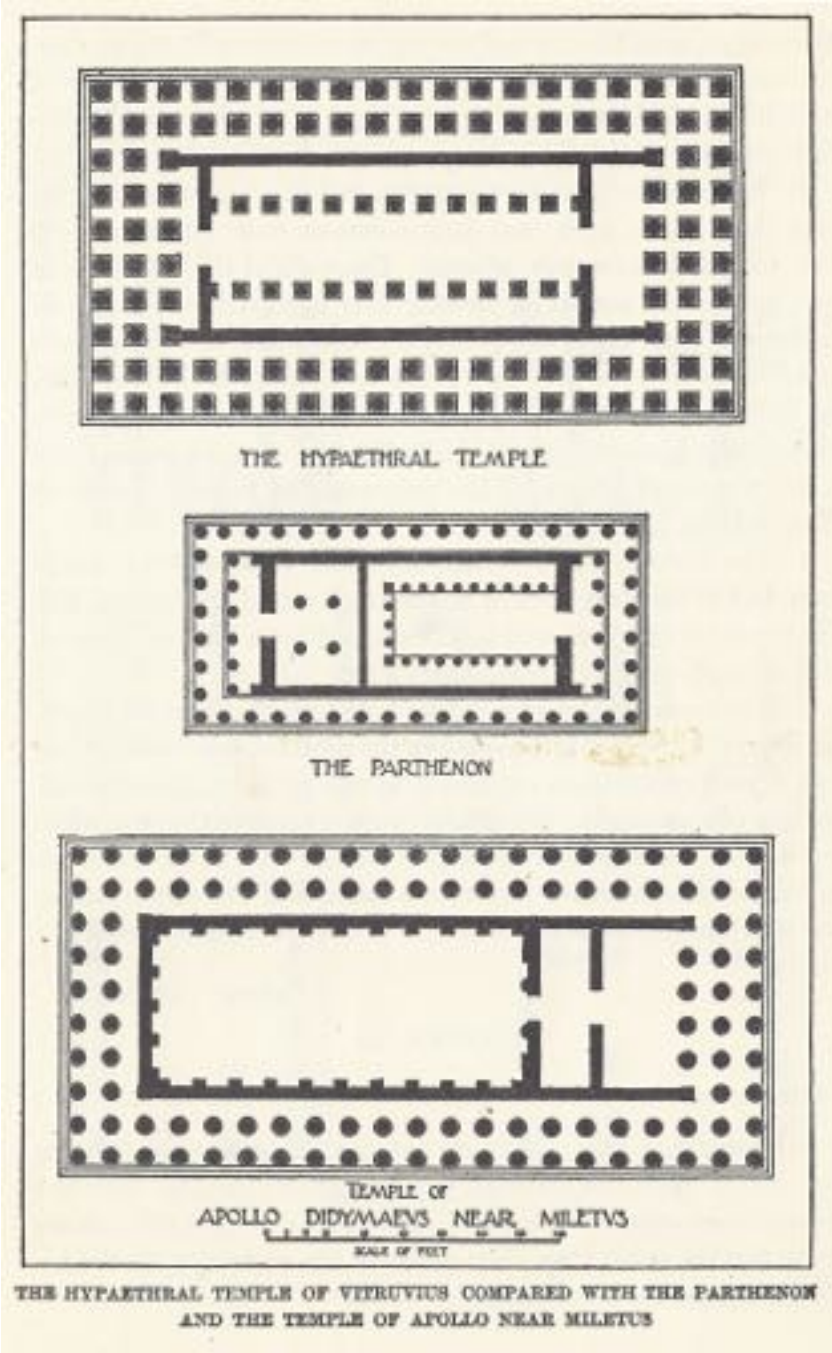


Figure 2.1: The Vitruvian hypaethral temple from Morgan (1960, p. 77)

Stage-Based Models

Stage-based models of design consider the design process a consisting of distinct phases or discrete chunks and provide a model that moves from conception to realisation. A review of design models by Tate and Nordlund

(1996) recognises a number of stage-based models including those by Evbuomwan et al. (1996), Asimow (1962), VDI 2221 (VDI, 1993), Pahl et al. (2007), Jänsch and Birkhofer (2006) and Hubka and Eder (1988). These stand in contrast to models based on design activities and assume discrete phases design activity, a beginning and an end to the process and iterative operational cycles.

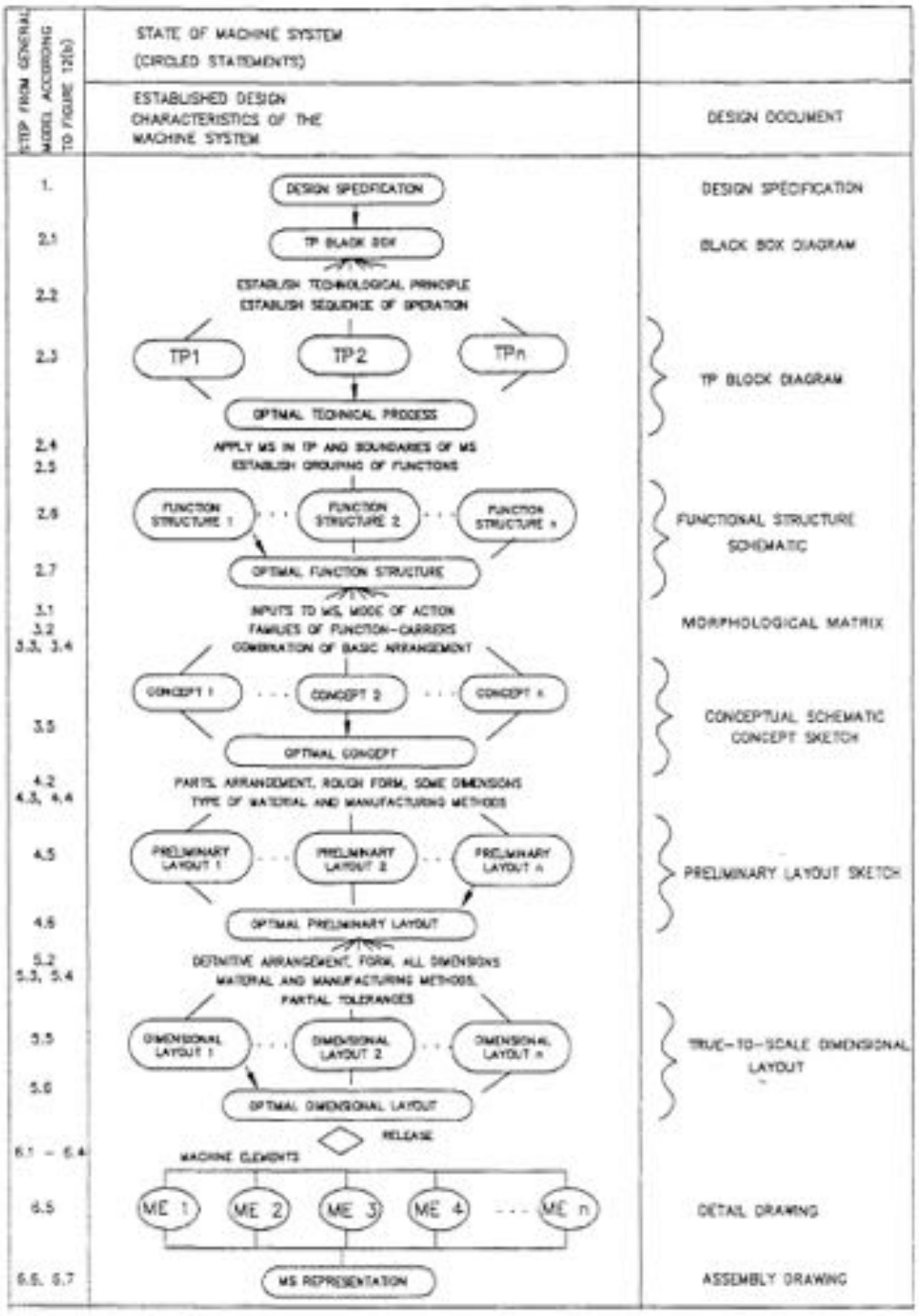


Figure 2.2: Hubka's procedural model of design from Evbuomwan et al. (1996, p. 309)

Most models describe a movement from abstract ideas to concrete realisation (Asimow, 1962, Smithies, 1981, Watts, 1966) or from problem definition to concept design to detail design (Pahl et al., 2007, French, 1985, Hubka and Eder, 2012, Royal Institute of British Architects, 2013). Some models also describe activities within that process, for example Asimow (1962) describes a lateral process of *analysis - synthesis - evaluation – communication* which occurs simultaneously with the vertical phases of design. Smithies (1981) describes a spiralling roundel, with each iteration the design gaining clarity and moving closer to the notional solution centre point (figure 2.1). An initial tentative solution (X) is considered against the various factors of the design problem (A,B,C,D) gaining refinement through various iterations. The *iconic model* offers a similar approximation whereby the design moves from the abstract to the concrete.

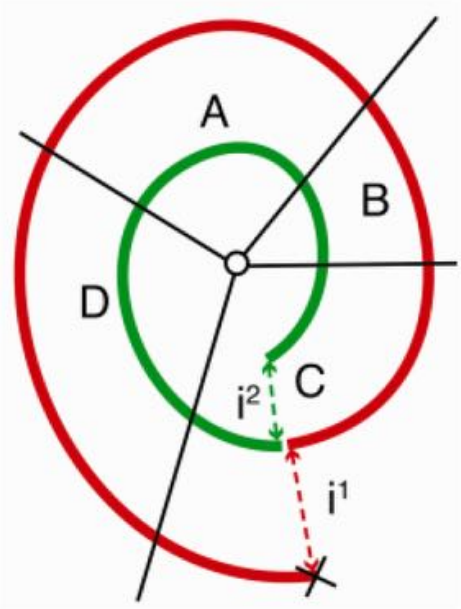


Figure 2.3: Wright's design roundel developed from Smithies (1981) from Wright (2011, p. 111)

Activity Based Models

Activity based procedural models, describe the individual tasks of the designer to generate possible solutions. In most cases the literature reviewed assumes an *analysis/synthesis* approach, that is an analysis of the initial problem followed by a synthesis of possible solutions. Models such as those by Krick (1965) and Harris (1980) also include decision and evaluation stages to assess the suitability of different solutions. The primary characteristic of these models is

that the synthesis is borne from a deterministic understanding of the nature of the problem and is preceded by analysis.

The implication of such deductive theories the aims to reduce the designer's need to rely on intuition or rules of thumb through deterministic processes (Hillier et al., 1972). There will always, however, remain a disjunction between the stated requirements of the problem and their translation into architecture. The preparation of any architectural programme requires the existence of an initial idea or form (Anay, 2006a). Moreover, the analysis stage can never be a purely objective exercise and the programme will inevitably be biased, with some implication of the completed form (Rowe, 1996).

An assumption of procedural approaches is that design begins with a definable and containable problem. Simon (1977) asserts that even ill-defined problems have an underlying structure that can be broken down into a series of steps however the literature regarding wicked problems suggests this is not always the case or the means of reduction may not be apparent, especially in novice designers. As soon as one accepts the notion of the *design situation* as opposed to the *design problem*, procedural processes become severely limited.

2.2.4 Heuristic Models of Design

As Cross (1982) notes, the fundamental nature of design problems mean analytical or deductive techniques are often unsatisfactory. Cross (1972) and Lawson (1979) used analysis of practical examples to understand the processes of designers, each revealing the complexity of design processes. Lawson (1979) identified different cognitive strategies used by trained architects and scientists. When given the same problem, architects generally opted for a solution focused approach where a series of synthesised options were tested against the desired outcome. In contrast, the scientists were more likely to take an analytical approach, whereby the problem was dissected to reveal principles that gave rise to a solution.

Reflective practice

Schon (1992) advocates a reflective practice based model in which the designer must engage in a constant dialogue with one's mentally formed design world and the real world through the physical tools of the designer. A frame of

reference based on the problem-situation is developed through engaging with the tools of design. Design is not seen as a form of applied science but emerges from the context of its own generation (Lie, 2011). The theory favours active techniques to create knowledge which can then be reflected on to inform further understanding.

Emphasising a practical approach, the reflective model excludes basic knowledge acquisition and it is unclear how learnt design knowledge may be usefully applied. In order to construct a sufficient cognitive frame for problem solving relies on some kind of pre-structuring or *a priori* understanding. Moreover, mastery of designer's tools is also necessary to fully engage with the process which must be learnt (Waks, 2001).

Hermeneutic Models and the Critical Method

Various hermeneutic models focus on understanding and the creation of meaning within the design process. Multiple theories (Bamford, 2002, Hillier et al., 1972, Darke, 1979, Snodgrass and Coyne, 1992) share a common concern for the role of interpretation and tacit experience. Central to this is the role of the internal cognitive process of the designer and their powers of idea generation.

Hillier et al. (1972) suggest a *conjecture - analysis* model, analogous to the critical rationalism developed by Popper (1963, 1959). The paradigm proposed by Darke (1979) for design elaborates further on this understanding and interprets design as a processes of *generator - conjecture - analysis* (p.38). A primary generator may act as a *'way in to the problem'* (p. 38) but is usually derived from the architect's cognitive structures. Darke suggests there is a '*rationality gap*' where a visual concept may be adopted prior to rational justification or its analysis does not dictate a particular idea should be pursued. The process is developed further in Brawne's Critical Method (CM) (2003). The process can be summarised as:

$PD^1 \rightarrow TS^1 \rightarrow DD^1 \rightarrow PD^2 \rightarrow .....$

Where PD^1 is the initial problem definition, TS^1 trial solutions and DD^1 design development (Brawne, 1992, Wright, 2011).

The implications for the integration of design knowledge are noted by Hillier et al. (1972) and should *'provide designers with a stronger theoretical, operational and heuristic basis from which to conjecture rather than in terms of knowledge to determine outcomes.'* (p.1). In Popper's model, existing scientific knowledge is the basis of conjecture and according to Brawne (2003) the model offers a balance between continuity and innovation.

The process, however, suggests, design is a process of guesswork based on innate or learned cognitive abilities to generate applicable design solutions. Bamford (2002) highlights the problem, and its implication that all knowledge is reduced to conjecture and accordingly, despite attempts to define a systematic methodology, the design process becomes one of trial and error. Design is not just *'unremitting guess work'* (p. 260) and learnt knowledge is an important aspect of the process.

2.2.5 Primary Generators

The notion of primary generators was proposed by Darke (1979) and could be considered a key aspect of heuristic design processes. Primary generators describe the designer's initial starting point are inherited from learnt knowledge. Novice designers, with unsophisticated and limited set of primary generators, will often struggle to generate viable design solutions. As Wright (2011) notes: *'The process by which designs are generated appears ill-defined and quasi-mysterious. Students, when faced with a problem and a blank sheet of paper, are offered little in terms of ways to generate design solutions'.* (p.114)

Primary-generators may be visual concepts or set of related ideas, however, according to Leupen (2002), their cognitive origins are an *'invention of the modern era'*. Kaufmann (1957) suggests that before 1900, architects predominantly designed using pre-defined systems to approach problems, and spatial arrangement and composition were determined by the prevailing architectural style. According to Leupen (2002), *'Loos attacks ornamentation, Le Corbusier redefines classical composition and Rietveld and Mies van der Rohe open up spatial arrangement'* (p. 108). Architects were free to invent their own systems and designs sought uniqueness through *'concept'*.

Rowe (1987) identifies five categories of primary generators based on the kind of information they provide: environmental relationships; typologies; formal

languages; anthropometric analogies; literal analogies. Wright (2011) offers fourteen ways to generate design, falling into three broad categories of typology, determinism and abstraction. These techniques can be understood more concisely as being either abstract or empirical.

Abstract primary generators employ something other than architectural example to generate a problem space. Non-architectural analogies, programmatic determinism, pseudo-scientific rationales and allegorical narratives all provide examples of this. One advantage is abstraction does not rely on a wide knowledge base and a decision-making framework can be easily constructed by the novice designer. As Wright (2011) notes however, based on a lack of knowledge or architectural experience, novice designers often resort to abstract concepts for justification and fail to transcend their metaphorical connotations.

Empirical techniques rely on knowledge of pre-existing conditions that may be relevant to the problem. These may include: spatial, formal or programmatic typologies; stylistic architectural languages; architectural conditions embedded in secondary visual or verbal media. The clear advantage of this is they may represent proven cases of successful design strategies. Moreover, according to Jacoby (2013) through such empiricism, *'form acquires a multi-layered historical, social, cultural, and symbolic dimension'* (p.2).

2.3 Discussion

The architectural project, the design of a building from brief to construction to post-occupancy, cannot be considered a problem solving activity in the traditional sense. Subject to processes of conceptual expansion, it can be helpful to consider the project a *'design situation'* in which a variety of activities take place, distinct from purely inductive, deductive or abductive processes. Design situations are characterised by: poorly defined and/or conflicting aspirational values; ambiguous and disputable working processes and accepted principles; and no clear idea of the final design outcome.

The '*wickedness'* of design problems make purely deductive techniques un-workable and the designer is always required to make a conjectural leap to generate trial solutions. The open ended and undefined nature of design limits the validity of stage-based models or problem-solving activity based models.

Heuristic methods allow designers' innate primary generators to form an integral part of the design process. Hillier et al. (1972) suggest that design is a process of *'pre-structuring problems, either implicitly or explicitly'* to allow them to be analysed rationally or empirically. Pre-structuring may provide a coherent framework for both the generation of ideas and a reference point for analysis.

The Critical Method (CM) offers a model of design heuristics that acknowledges the role of tacit knowledge and conjecture as key components of the design process. As a method it also allows the utilisation of a variety of problem solving techniques, idea generation and analytical methods.

In CM, the notion of historical precedent is paramount and provides the closest approximation to the Popperian epistemology. According to Popper (1963): *'Knowledge cannot start from nothing - from a tabula rasa - nor yet from observation. The advance of knowledge consists, mainly, in the modification of early knowledge*' (p.36-37). Architectural knowledge resides in built forms, in precedents and existing urban fabric and typology offers a means of interpreting this knowledge. This is acknowledged by Brawne (2003): *'…since it [CM] is based on both earlier precedents, on an awareness of the past, and equally on the severest possible criticism of those examples before acceptance, there may be a reasonable balance between continuity and innovation'* (p.36).

Procedural methods may offer opportunities to simplify the design process for novice designers. Curry (2014) suggests using different design paradigms as teaching strategies depending on the experience of the learner and suggesting it may be helpful to consider design as a problem solving activity with novice designers. Bamford (2002) calls for a *'taxonomy of tasks in design'* (p.260) to better understand the role of CM and its implications in the design process.

There still appears a place for stage-based models of design despite their overly simplified and apparently rigid structure and the widespread use of the RIBA's Plan of Work (2013) is testimony to this. A conceptual synthesis can be made between the a phase based model of design and the Critical Method whereby the former describes the overarching process and the latter the individual heuristic activity. This hybrid model shares similarities with those of Asimow (1962) and Watts (1966) but rather than conceiving of design as series of problems at each stage, it emphasises the importance of independence and non procedural activities. As the designer moves through this iterative cycle,

the stages exist more as mile stones rather than discrete parcels of activity, which may move and shift within the overall framework.

3.0 LITERATURE REVIEW OF TYPOLOGY

3.1 A Critical History

In any architectural discourse, it is impossible to avoid the notion of type. As Moneo (1978) asserts: *'the very act of naming the architectural object is a process that from the nature of language, is forced to typify'*. Like words, types have a general meaning that describes common characteristics of real world phenomena yet the meaning of any individual word or type is wholly dependent on context, delivery, and interpretation.

Acknowledging that a given design singularity shares some common characteristics with precedent, and that the situational nature of the architectural object make it unique, typologies provide a way of connecting the particular to the universal. Analysis and synthesis necessitate abstraction of the real or the potential, prompting type formation.

At this stage, it is important to distinguish between the notions of typology and of type which are often used interchangeably. Jacoby (2013) turns to Johnson (1994) for definition: *'strictly, "typology" is the knowledge (-logy, Greek logos) and study of types, their succession and their meaning or symbolism, the systemics of types, or the categorical overview of types. [...] To say, for example, that the temple is a "typology" if what is meant is that it is one type of shrine, or to use "typological" as the adjectival form instead of "typical" or "typal", merely confuses'* (p. 291). Typology denotes the field of study of types (Jacoby, 2013). The method of categorisation may vary and that gives rise to different typologies. Precedents are also distinct and describe a single instance or isolated example in contrast to a type, which is a non-physical category, or a typology, which refers to the means of categorising.

Typology, the formalised study of types, has only been apparent in architectural theory since the enlightenment (Jacoby, 2013). The first theories of typology, at the turn of the 19th Century, coincided with the efforts of classification in the natural sciences (Steadman, 1979). *'Architects and natural historians were faced with similar problems, for one the rapidly increasing number of building functions and for the other a vast increase in the discovery of species'* (p. 26). The hope was that ordering the buildings, or species of the past, would reveal principles which may be applied to design or, in the case of biology, reveal theoretical new species. Considering knowledge as obtainable through

abstraction, categorising historical artefacts provided a means to scientifically interpret the past.

Historical discourses on typology have tended to consider three distinct phases in its development and interpretation. Vidler (1977) identified these as: typologies of architectural origins (such as in Enlightenment thinking); typologies of construction and physical production of architecture (promoted in the modern movement); typologies of urban morphology and social production (as in the neo-rationalist movement). This structure is echoed by Moneo (1978), Güney (2007) and more recently Carl (2011) who identifies a fourth strand in computational design, parametric modelling and the digital manipulation of formal types. An extensive review of typological theories by Jacoby (2013) considers a further defining phase of typological theory as beginning in the middle of the 1970s constituting the historical analyses of Vidler (1977), Moneo (1978) and Oechslin (1986).

Argan (1963) provides an alternative structure of this discourse, considering types in relation to the design process through a hierarchical structure of typologies: *'The first concerned with a complete configuration of buildings, the second with major structural elements, and the third with decorative elements.'*. This hierarchy is seen to mirror the design process, from plan to structure to surface treatment. Whilst Argan's model may only provide a crude interpretation of both the design process and theories of typology, it nevertheless provides a means of structuring historical discourse in a means that may relate to the practical application of typology.

Argan's philosophy conceives as typology as a notional base for formal construction, and deals with fundamental architectural problems. Type represents common *root forms* of any number of complex variants, analogous to formal and functional properties. As Nesbitt (1996) however notes, the essay never addresses what the *fundamental* problems might be yet presupposes a direct relationship between function and type. The distinction of what constitutes a significant enough new demand to give rise to a unique type remains unclear and thus the relevance of historical types in the design process is ambiguous.

Synthesising Argan's hierarchical interpretation of typologies with distinct historical phases identified by Moneo, Vidler and Carl, one may identify four distinct modes of typological thought: Metaphorical typologies, systemic

typologies, elemental typologies and literal typologies described in table 3.1. This categorisation forms a natural hierarchy whereby metaphorical typologies require the greatest level of analysis and abstraction, and literal typologies require the least.

Typological Level	Typologies	Examples
Metaphorical	Cultural Contextual Experiential	Quatremère de Quincy (1832) Semper (1985) Vidler (1977) Rossi et al. (1982) Carl (2011) Kärrholm (2013)
Systemic	Spatial Structural Organisational	Krier et al. (1988) Von Meiss (2013)
Elemental	Functional Visual Technological	Vitruvius (Rowland and Howe, 2001) Alberti (1775) Durand (1809) Steadman and Mitchell (2010)
Literal	Prototypical	Corbusier (1987)

Table 3.1: Categorisation of Typologies

3.1.1 Metaphorical Typologies

Antoine-Chrysostome Quatremère de Quincy is commonly credited with the first formal notions of typology in architectural history (Jacoby, 2013) described in his *Dictionnaire Historique de l'Architecture* (1832). He considered *type* as a metaphorical entity, as distinct from *model* (which was a form that could be emulated) (Güney, 2007). Typology as a means to connect the singularity of architecture with its past (Moneo, 1978) and its universality could form the basis of any number of unique outcomes. To Quatremère there were three principal types from which all architecture was derived*; 'the tent, underground [caverns], and the hut or carpentry'* (Lavin, 1992). Relating the formation of architecture to its origins *'endows every element with symbolic significance'* (Lathouri, 2011).

As Lavin (1992) points out, Quatremère's theory suggested architecture had a social origin, and was the result of *'society's invention of a universal system that made every architecture a language'* (p. 100). It was imperative that the most appropriate language be selected that represents a society's concerns most accurately. The connection between past and contemporary architecture was seen as typological, and any new work of art a transformation of type. For

Quatremère, type becomes the embodiment of social meaning and thus its usage is imperative.

Quatremère's neo-platonic approach assumes a series of ideal forms; indivisible constructs which embody the act of dwelling. Subsequently, architecture is driven by dwelling and the three principal types are their purest manifestation. The theory develops conceptual ideas of origins and imitation from Marc-Antoine Laugier, Winckelmann, and Ribart de Chamoust (Jacoby, 2013) yet moves away from the singular type of the hut. Henry Home, Lord Kames' proposed in Sketches of history of Man (2007) that progression through the three primitive states of man, the three principle types are related to each of these anthropological conditions: the hunter and the cave; the shepherd and the tent; the farmer and the hut. Establishing types as anthropologically derived forms, a product of human endeavour, they become containers of social and cultural values.

Figure 3.1: Charles Eisen's engraving for the second edition of Essai sur l'Architecture (1755) taken from Laugier (1977)

As Lavin (1992) recognises, Quatremère differs from many of his contemporaries by defining the history of architecture in social terms, implying a profane rather than divine origin of man. His project mimics the universality of Newtonian synthesis; a reductionist version of history that reconstructs its path in rational terms.

Like Quatremère, Gottfried Semper's doctrine of style links basic human experience with the physical world. Four elements (the hearth, the mound,

enclosure and the roof) common across antiquity, fulfilled physical and spiritual universal human needs (Anderson, 1982). These indivisible *urtypen* were from which all other forms evolved, characterised by their function and were linked to processes as opposed to any particular form (Spelman, 1997). According to Semper:

'the different technical skills of man became organised according to these elements: ceramics and afterwards metal works around the hearth, water and masonry works around the mound, carpentry around the roof and its accessories. But what primitive technique evolved from the enclosure? None other than the art of the wall-fitter, that is the weaver of mats and carpets' (from Hale, 2005, p. 47).

The artistic object is a unique transformation of these basic types through the act of construction; the hut for example could be considered a response to an essential human need but the process of its making, techniques and materials, operate within a constantly changing social context. It is in the craft of making that a poetic language develops and thus a building becomes both ontological and representational (Hale, 2005). '*Style'* was rooted in tectonics and determined how the artefact may communicate thus finding an appropriate contextual *grammar* became essential. For Semper, style was the result of the primordial types, intrinsic technical influences (materials and technology) and extrinsic influences (e.g. climate, culture, religion etc).

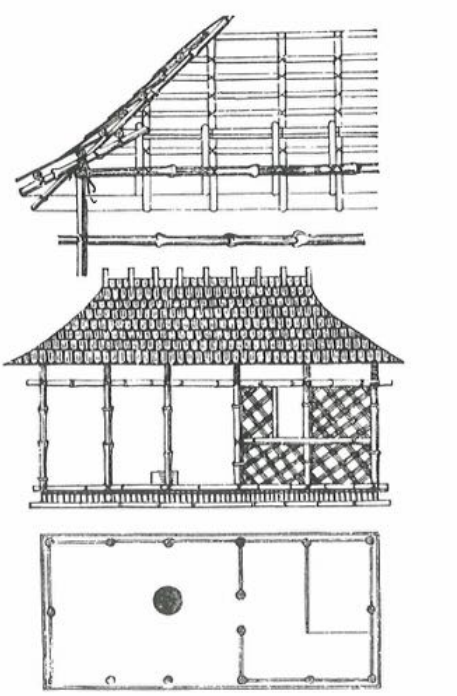


Figure 3.2: A primitive Caribbean hut from Herrmann (1984, p.170)

Semper's notion of style was dynamic, and constantly needed to adapt to society's changing needs. It was in the cladding of the building, *Bekleidung*, that expressed these needs. Ornament could be structural-symbolic, tectonically derived decoration that had been symbolically transformed. Alternatively, incrustation was derived from the original enclosure, the hanging mat or carpet that communicated social meaning and iconography (Spelman, 1997).

Semper's doctrine shares similarities with Bötticher and before that Schinkel (Gutschow, 2000). Bötticher distinguished between the structure of the building (*Kernform*) and its representation (*Kunstform*) yet the two were linked by the purpose of the *Kunstform* to represent the *nucleus* of the building. His theory of tectonics outlined in *Die Tektonik der Hellenen* (1852) worked backwards to hypothesise a deterministic historical progression of architectural expression, furnished with the characteristics of traits specific to different cultures. He suggested a universal progression of ever larger spaces being spanned by ever smaller members and architecture simultaneously took on greater level of representation and allowed a greater number of building types to exist (Gutschow, 2000). Schwarzer (1993) remarks that *'architecture was no longer conceived of as a finite world of forms, rather, it became a dynamic and infinite universe of forces.'* As Jacoby (2013) suggests both Semper and Bötticher considered typology in stylistic terms and *'understood the development of typal*

motives and their transformation in art-forms in relation to cultural and material influences' (p.143).

Various theories arose in the 1960s and 1970s reacting to the modernist rejection of historical type. Neo-rationalist thought, particularly of Aldo Rossi, focused on re-using the forms of the city which is seen as a continuous morphology, a product of social order rather than of function or use. Like Quatremère, Rossi considers type as being the *'very idea of architecture'* and in this sense considers all theories of architecture theories of type (Rossi et al., 1982, p. 41). Any one type may manifest itself in any number of forms and all forms are reducible to type. Classification of types is of basic formal structures, for example the use of the central plan in religious architecture, however other themes come into play (its function or construction technique) when a specific architecture is generated. Rossi allows special status to dwellings claiming that *'housing types have not changed from antiquity to today'*. This is evident in his analysis of Berlin, in which he identifies three categories of housing (residential blocks, semi-detached houses and single family houses).

His reluctance to further abstract the type to basic formal arrangements underlines one of the key problems with Rossi's notion of type; that the universal forms, from which governing principles are derived, are bound with their context, usage and function. Rossi acknowledges this fact, accepts functional classification '*as a practical and contingent criterion'* (p. 48) however it is equivalent to any other criteria of classification such as social makeup or constructional system. Type cannot therefore be defined by function alone but becomes a complex interplay of factors that define the characteristic principles of architecture or the city. The notion of time becomes an important aspect in this definition of *'...elements whose function has been lost over time; the value of these artefacts often resides solely in their form'* (p. 60) and as such the functional classification of type become irrelevant to these *'persistent urban artefacts'* (p. 61).

Rowe (1987) argues that the re-composition of urban elements has the potential for irony as the *'comprehension of new meaning through a shift in context'* (p192). According to Vidler (1977) in the hands of a skilled practitioner this can be used as critical socio-political tool demonstrated by Rossi in his Trieste Regional Hall which references prison architecture to question the condition of civic power (Rowe, 1987). Conversely, the architect may consciously choose to subvert the status of the borrowed type and challenge its architectural

prevalence which Braham (2000) argues undermines historicism, failing to invoke the original subjectivisms associated with each type.

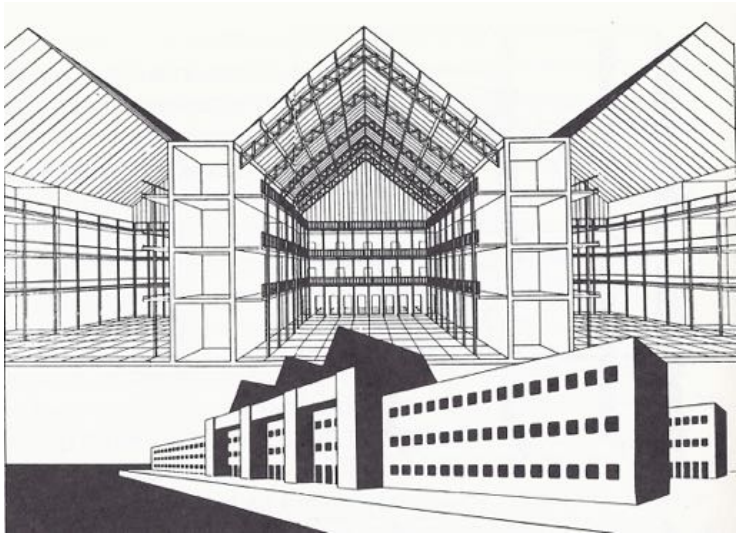


Figure 3.3: Rossi's completion entry for Trieste Town Hall from Rowe (1987, p. 194)

Carl (2011) reconsiders type as *the typical*, encapsulating the variety, richness and depth of common human experiences. Rather than the systematic utilisation of abstract types, he suggests a theory of *typicalities* embedded in their context and situations, the city being the being the most '*concrete receptacle of these universal conditions'* (p. 43). Type may '*operate like a question, soliciting debate and commitment to a theme or topic'* (p. 43). Carl illustrates this with his sketch of a reconstruction of a shrine from Catal Hoyuk interpreting nature as common to all, therefore the most typical. According to Carl, *'the shrines are distinguishable from the dwellings only by the presence of the horned stanchions, buchrania, etc, which develop carefully placed and oriented settings within that of the dwelling.'* (p. 41).

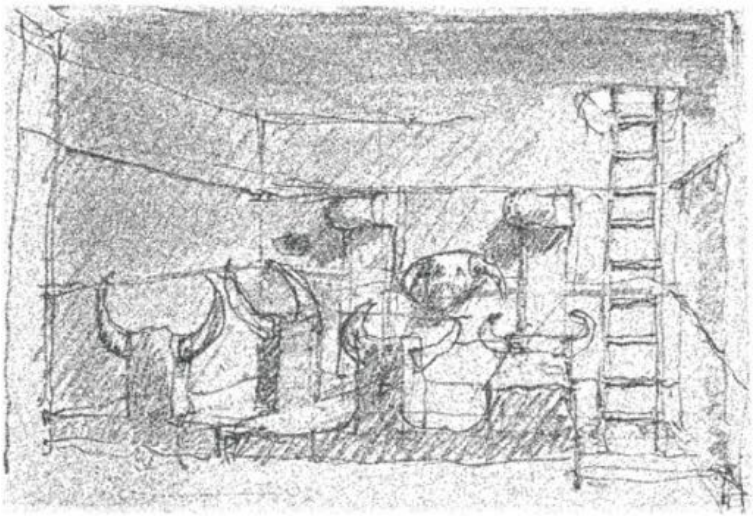


Figure 3.4: Reconstruction of a Shrine from Level VI of Catal Hoyuk, Turkey, c 6th Millennium BC (Carl, 2011, p. 41)

Kärrholm (2013) draws from actor-network theory and object-oriented philosophy to develop a theory of '*territorial sorts'*. Whereas types are generally defined by their production, he suggests a more diverse approach that takes into account the changing and diverse user perspective of buildings. A territorial sort *'could be used to describe a set of related territorial productions that can all be associated with a similar set of activities'* (p.1121), autonomously transforming or utilised to manipulate types. As Kärrholm notes, types themselves may act upon their context playing *'active parts in societal change and in the ongoing power relations in the urban landscape'* (p.1118). If type is understood to be produced by continuous relationship between various factors, its characteristics and effects can only ever be temporary thus undermining its universality.

In metaphorical typologies, categorisation occurs at the cultural, symbolic or contextual level. It operates in an abstract manner, a shorthand for a set of intangible values.

3.1.2 Systemic Typologies

Systemic typologies derive categorisation from organisational systems embedded in architecture, whether spatial, formal or structural. They are distinct from the metaphorical categorisation in that selection and appropriateness is judged on practical rather than conceptual value.

J.N.L. Durand considered an empirical typology (Jacoby, 2013) whereby building axes, defined by diagrammatic abstractions of functional types, are then furnished with pre-defined components forming models for emulation (Moneo 1978). Any number of permutations of building could be formed, connecting architectural singularities directly to the past through a shared visual language. Part 3 of his *Précis on the Lectures of Architecture* breaks down the city into its constituent parts; elements of the city (city gates, streets, public squares etc), public buildings (temples, libraries, colleges etc) and private buildings (townhouses, apartments, tenements etc) (Durand, 1809). For each part he offers a brief discourse relating them back to classical antiquity as well as illustrations of model examples.

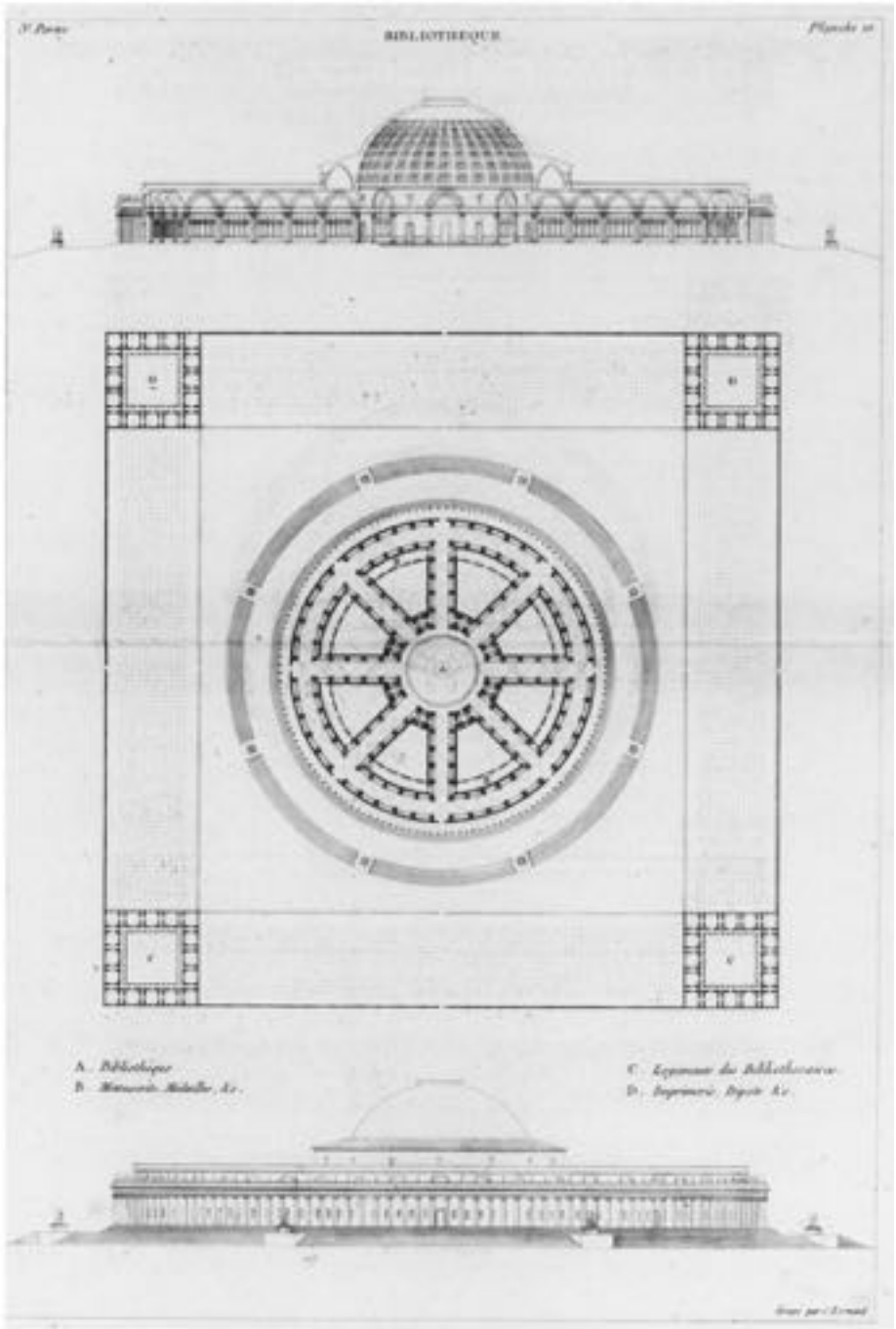


Figure 3.5: J-N-L Durand, Précis des leçons d'architecture donnéhs à l'École Polytechnique, 1802 & 1805; plate 10 from Brawne (2003, p. 18)

As Steadman (1979) remarks, however, Durand's method is essentially a geometrical one and not functional at all. Rooms are assigned functions and circulation is abstractly mapped onto the symmetrical plan form. Moreover, Durand's method of classification does not account for changing functional requirements, assuming that the city is constructed of a series of static functions. It was his intention to enable students to design through modification

of the general function type to meet more specific briefs and requirements however it is unclear how such an approach may be adopted to entirely unanticipated functional requirements. New buildings were adaptations of existing models and accepted systems guided the hand of the designer.

Rob Krier's work on spatial typologies represents an abstraction of common spatial conditions and could be compared to that of Durand. As Friedrich Achleitner notes *'Krier would appear to concern him with history only insofar as it guarantees him a certain constancy of spatial experience'* (Krier et al., 1988, p. 8). In Krier's own sketches for the residential accommodation on Schinkelplatz he describes the spatial configurations as *neutral* which can be '*used independently of time and culture*' (p. 63). For Krier, it appears the experience of the architectural condition is enough to warrant its re-appropriation and new forms are generated through the adaptation of proven typological patterns of construction.

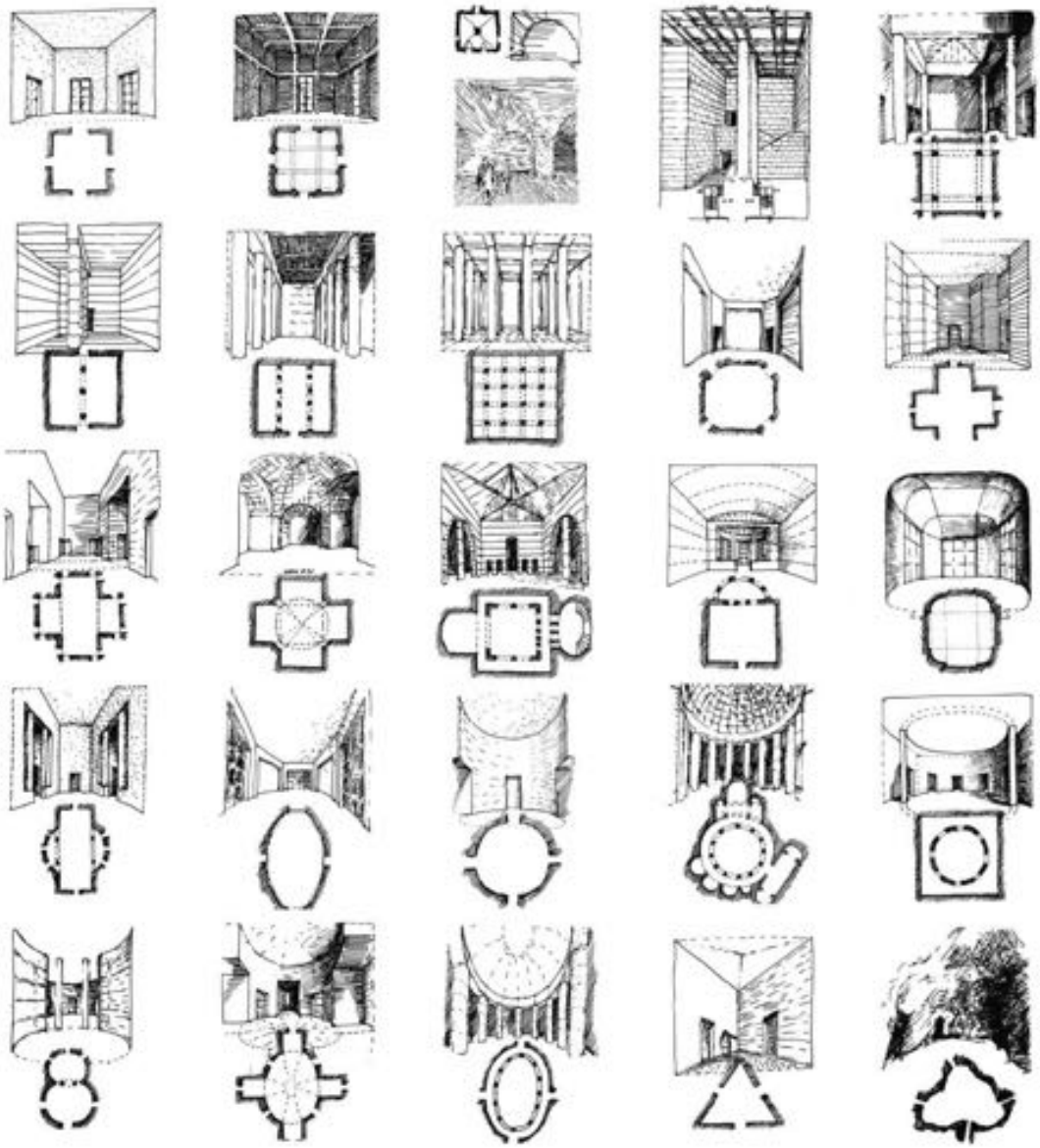


Figure 3.6: Spatial types from Krier et al. (1988, p. 2)

De-contextualising architecture allows Krier to systematically test any number of typologies against a brief or criteria and select the most appropriate. The classification and selection of these typologies remains unclear. Presumably the number of typologies is limited to the designer's personal experience and its selection must eventually come down to a subjective choice on the most relevant spatial condition once all the relevant criteria have been satisfied. Moreover, the phenomenological experience of any space is in part dependent on social context and as such the same architectural condition could be understood differently in alternative scenarios. To successfully utilise an abstracted type must therefore rely on an in depth knowledge of the context in which is to be applied to allow for successful selection and adaptation.

Steadman and Mitchell (2010) provide a means of defining types through the development of an *Architectural Morphospace*, a coordinate system on which all possible built forms can be plotted. The method involves the creation of an archetypal building from which arrangements of courtyards, wings and ranges can be cut by selecting or omitting certain parts of the model. Each unique plan form can then be plotted onto a coordinates system and ultimately represented by and *x* string and *y* string which represent the included or omitted elements of the archetypal form. This approach allows architecture not be defined by discrete typologies but as a continuum. Nevertheless, representation on such a matrix allows families to be grouped, either arbitrarily or through setting distinct boundaries.

Steadman's classification is one of spatial archetypes and provides a systematic method for the understanding of previous built forms, albeit only on a formal level. The abstract nature of the system allows the extraction of specific design knowledge without the risk of direct emulation of the initial precedent. It also offers a means of locating new designs on the matrix to allow for comparisons or to be used in the briefing stages of the project to spatially categorise a likely solution. The constraints of the matrix mean only forms which can be derived from the initial archetype can be mapped and as such, its effectiveness as a tool for interpreting a variety of historical forms is limited. Steadman's discourse is furnished with historical examples of buildings, and the programmatic requirements that gave rise to their form and their position on the matrix yet abstraction to this level involves an inevitable stripping of meaning; buildings are reduced to binary strings of 1s and 0s.

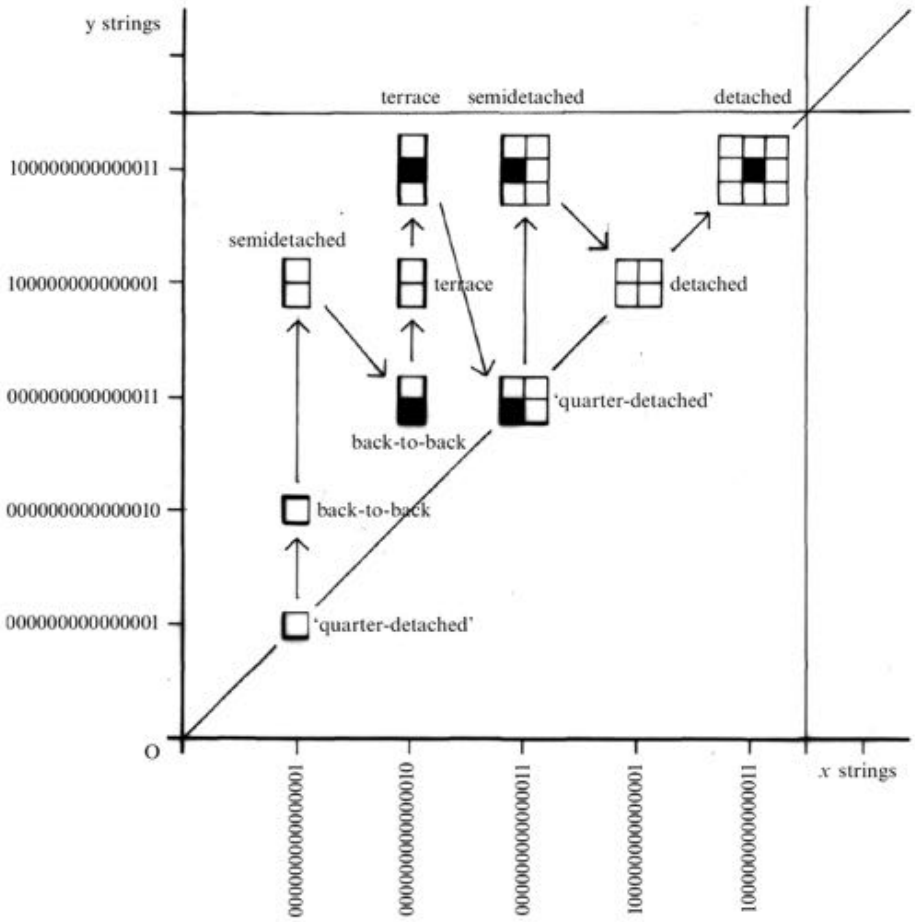


Figure 3.7: Mapping Steadman's Architectural Morphospace (Steadman and Mitchell, 2010, p. 207)

Von Meiss (2013) provides seven basic principles of spatial organisation as a basis of most, if not all architecture. These are; linear, centralised, radial, the form of a crown, the grid plan, the cluster and the plan libre. Whilst he appears to derive these categories from an analysis of historical precedent, the system does not account for potentially undiscovered forms nor the combination or overlapping of the existing defined forms. Nevertheless it provides a clear system for classifying spatial arrangements which can be selected depending on site or programme. Unlike Steadman's system which provides only abstract organisation, von Meiss's categories are based on proven architectural conditions and as such utilise the success of these arrangements.

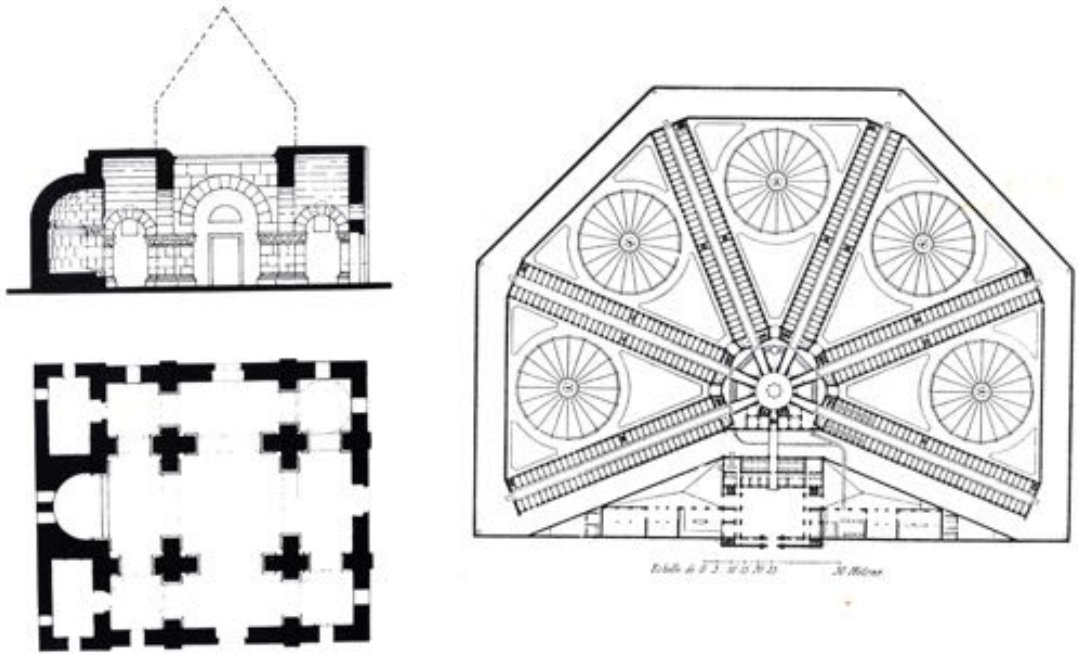


Figure 3.8: Centralised plan(major central palace, Resapo, Syria) and radial plan (former Mazas Prison, Paris) from Von Meiss (2013, p. 118-119)

In contrast, types may be generated from '*historical-theoretical preoccupations'* that may govern acknowledged typological categories (Rowe, 1987) (the French hotel, the basilica, or the classical temple for example). These exhibit an internalised architectural parlance that relies on a shared appreciation of these concepts however embody subjectivities of an architectural profession. Such classifications assume a direct and permanent relationship between form and meaning and therefore must conceptually separate these concepts, or must acknowledge their complex interrelationships.

3.1.3 Elemental Typologies

Elemental typologies remain distinct from systemic typologies in their specificity to individual parts and isolated problems. They do not represent overall strategies for universal application but specific instances for emulation.

The concept of elemental typology has existed since antiquity. Vitruvius's *Ten Books on Architecture* classifies buildings for the purposes of design (Rowland and Howe, 2001) in both functional and formal categories. Book V discusses the shared characteristics of forums, basilicas, theatres, palaestras, harbours and shipyards whilst Book III classifies temples by their arrangements of their colonnades (Amphiprostyle, Peripteral, Dipteral, Pseudodipteral etc).

For Vitruvius, it is a fundamental principle of architecture that a work is '*authoritatively constructed on approved principles'* (Vitruvius Pollio and Granger, 1983) These principles are based on those chosen by the '*ancients'*, their roots lying in nature, mathematics and mythology. Similarly, his typological classification is a descriptive tool, categorising inherited knowledge of how architecture *should* be. It represents inherited elements, without concern for the underlying rules that govern their creation. As Porphyrios (1991) notes: *'As long as the utensil or tool, as the product of craft, fulfils is still useful and is being used then its form, which was the outcome of pure necessity and usefulness in the first place, now becomes a typical form.*' (p. 30)

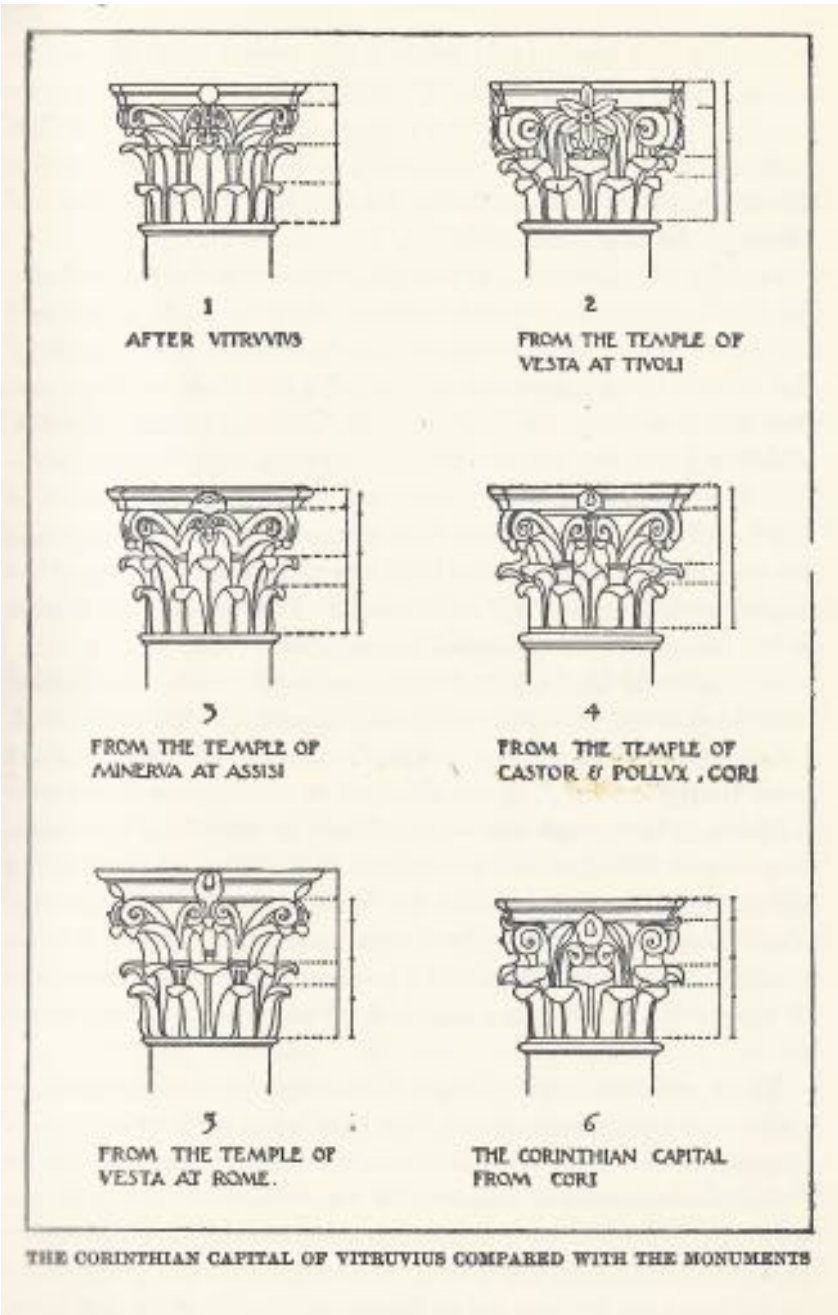


Figure 3.9: Corinthian capitals as architectural elements from Morgan (1960, p. 105)

Alberti's *De Re Aedificatoria* (1966) follows a similar pattern to Vitruvius's treatise, defining architectural types based on divisions in society (Eck, 1998). Book IV deals with public buildings and urban planning whilst book V considers private buildings arranged by the social status of their owner. As Van Eck asserts, there were earlier models for Alberti's treatise:

'In Isidore of Seville's Etymologiae, Book XV is devoted to architecture and agriculture (De aedificiis and agriis) and consists of a classification of building

types, a discussion of urban architecture based on the kino-aesthetic model, and etymologies.'
(p.287).

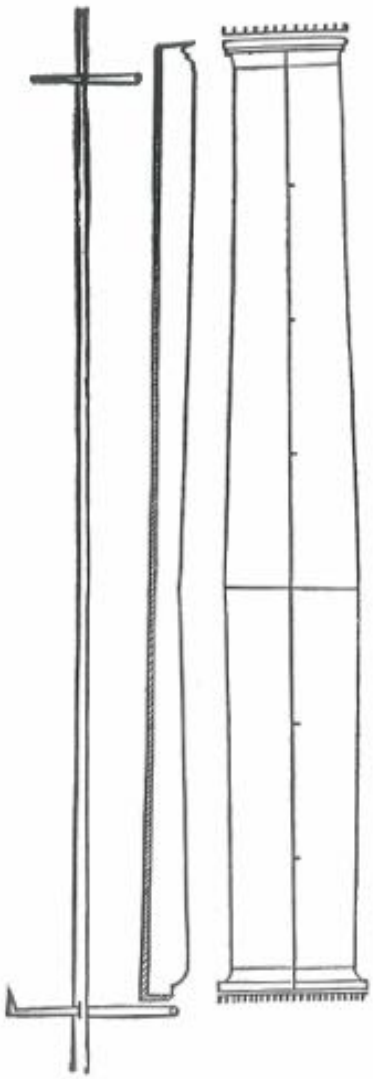


Figure 3.10: Method for determining the entasis of a column from Alberti (1988, p. 187)

Van Eck is careful to distance the work of Alberti from Vitruvius' earlier treatise. *'De Re Aedificatoria, is not a collection of instructions for the builder, but an enquiry into the principles of architecture considered as an essential contribution to civilised society'* (Eck, 1998, p. 292). Alberti's work is a reinvention of architecture based on the works of antiquity, and with it the re-establishment of the architect as author (Anstey et al., 2007). His description of each type is analytical. For example, at the start of book VII, when discussing ornament in sacred buildings:

'We shall develop our argument as clearly as possible, beginning with the articulation, description, and annotation of the parts of which the whole subject consists...we shall divide up the different parts of building art, to establish a clear and appropriate order in which to deal with the relevant considerations.' Alberti (1966) from (Eck, 1998).

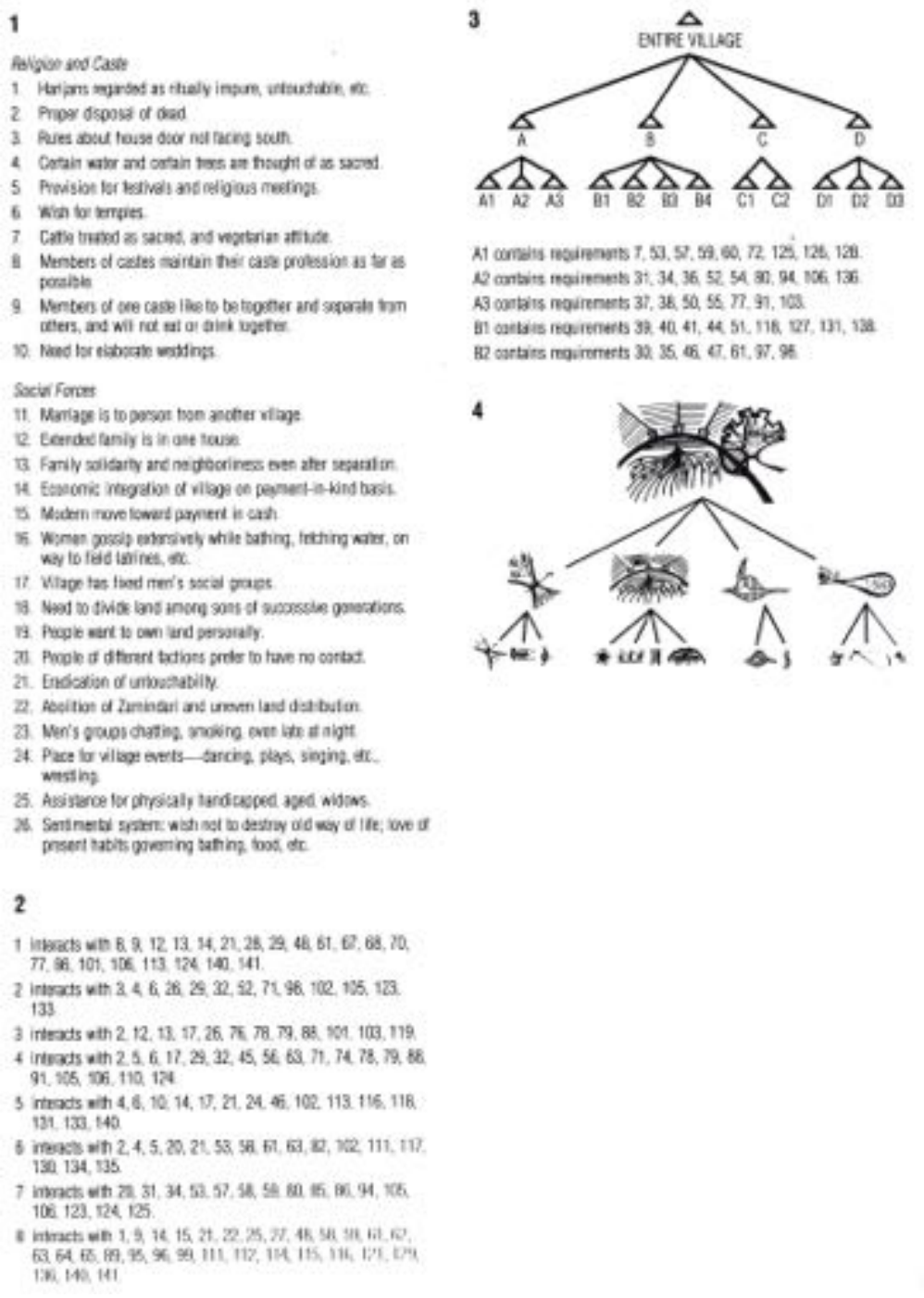
Despite differences in their purpose and tone, the types described in Alberti and Vitruvius' treatises are derived from function and the proper means of expression of associated form. There is considered a direct relationship between the building and the activities it contains and an assumption of an immutable socio-political structure relating to these types. This fixed nature does not account for shifting social requirements, changing building functions or technological changes in construction. They therefore exist only as snapshots, guides to construction in specific contexts. What is presented in both works is the notion of elemental forms, the idealised outcome of sets of underlying principles rather than the notional basis of architecture.

For Alberti, the skill of the architect was in manipulating the elements of composition (Anstey et al., 2007) in accordance with the principles of type laid out in *De Re Aedificatoria*. According to Lie (2011), such doctrinaire models *'provide categorical systems that designers use to claim jurisdiction and responsibility for tasks in design processes'* (p.97). The doctrine offers a prescribed analytical framework and design methodology used by the architect to synthesise a problem solution. In this sense the process is one of analysis/synthesis, albeit much of the analysis predetermined.

Christopher Alexander's books *A Timeless Way of Building* and *A Pattern Language* (1977, 1979) outline a systematic method of designing through the adoption of pre-determined patterns. The patterns are divided into towns, buildings and construction, operating at different scales and forming architecture through identification, combination and transformation. According to Alexander:

'Each pattern describes a problem which occurs over and over again in our environment, and then describes the core of the solution to that problem, in such a way that you can use this solution a million times over.'
(Alexander et al., 1977p. x)

One may consider each pattern a type, and Alexander offers archetypal examples of each pattern.



1

Religion and Caste

1. Harijans regarded as ritually impure, untouchable, etc.
2. Proper disposal of dead.
3. Rules about house door not facing south.
4. Certain water and certain trees are thought of as sacred.
5. Provision for festivals and religious meetings.
6. Wish for temples.
7. Cattle treated as sacred, and vegetarian attitude.
8. Members of castes maintain their caste profession as far as possible.
9. Members of one caste like to be together and separate from others, and will not eat or drink together.
10. Need for elaborate weddings.

Social Forces

11. Marriage is to person from another village.
12. Extended family is in one house.
13. Family solidarity and neighborliness even after separation.
14. Economic integration of village on payment-in-kind basis.
15. Modern move toward payment in cash.
16. Women gossip extensively while bathing, fetching water, on way to field latrines, etc.
17. Village has fixed men's social groups.
18. Need to divide land among sons of successive generations.
19. People want to own land personally.
20. People of different factions prefer to have no contact.
21. Eradication of untouchability.
22. Abolition of Zamindari and uneven land distribution.
23. Men's groups chatting, smoking, even late at night.
24. Pace for village events—dancing, plays, singing, etc., wrestling.
25. Assistance for physically handicapped, aged, widows.
26. Sentimental system: wish not to destroy old way of life; love of present habits governing bathing, food, etc.

2

1 interacts with 8, 9, 12, 13, 14, 21, 28, 29, 48, 61, 67, 68, 70, 77, 86, 101, 106, 113, 124, 140, 141.

2 interacts with 3, 4, 6, 26, 29, 32, 52, 71, 96, 102, 105, 123, 133.

3 interacts with 2, 12, 13, 17, 26, 76, 78, 79, 88, 101, 103, 119.

4 interacts with 2, 5, 6, 17, 29, 32, 45, 56, 63, 71, 74, 78, 79, 88, 91, 105, 106, 110, 124.

5 interacts with 4, 6, 10, 14, 17, 21, 24, 46, 102, 113, 116, 118, 131, 133, 140.

6 interacts with 2, 4, 5, 20, 21, 53, 58, 61, 63, 82, 102, 111, 117, 130, 134, 135.

7 interacts with 28, 31, 34, 53, 57, 58, 59, 60, 85, 86, 94, 105, 106, 123, 124, 125.

8 interacts with 1, 9, 14, 15, 21, 22, 25, 27, 48, 58, 59, 61, 62, 63, 64, 65, 89, 95, 96, 99, 111, 112, 114, 115, 116, 121, 129, 136, 140, 141.

3

A1 contains requirements 7, 53, 57, 59, 60, 72, 125, 126, 128.
A2 contains requirements 31, 34, 36, 52, 54, 80, 94, 106, 136.
A3 contains requirements 37, 38, 50, 55, 77, 91, 103.
B1 contains requirements 39, 40, 41, 44, 51, 116, 127, 131, 138.
B2 contains requirements 30, 35, 46, 47, 61, 97, 98.

4

Figure 3.11: Extracts from Christopher Alexander's Pattern Language adapted by Rowe (1987, p. 72)

The assumptions made by Alexander's elemental approach share direct similarities with the problem-solving conception of design advanced by Simon (1969). Not only is it assumed that architecture can be reduced to '*problems'* but also these problems are universal, finite and have unique solutions.

Alexander's typology may be considered purely elemental, a reduction of architecture to elements for emulation with limited analytical processes or influence by the designer.

Elemental theories of typology share similarities with the notion of craft and the idea of the emulation of models, patterns and rules. As Colquhoun (1969) notes:

'One of the most frequent arguments used against typological procedures in architecture has been that they are a vestige of an age of craft. It is held that the use of models by craftsmen became less necessary as development of scientific techniques enabled man to discover the general laws underlying the technical solutions of the pre-industrial age.'
(p.71)

3.1.4 Literal Typologies

The rejection of historical typologies can be linked to the rapidly changing socio-political environment and underlying ideologies of the early 20th Century. The modern movement ushered in re-interpretations of traditional notions of typology (Moneo, 1978) and the rejection of history as a driver for design lead architecture driven by deterministic processes, figurative space, or means of production (Moneo, 1978). Whilst functionalism gave rise to structural typologies derived from analytical processes, both the abstraction of space and embracing of mass-production undermined metaphorical, systemic and elemental types.

According to Moneo (1978), Mies van der Rohe exemplified the quest for the creation of idealised space. As Moneo asserts: *'Like the physicist, the architect must first know the elements of matter, of space itself. He is then able to isolate a portion of that space to form a precise building.'* Any connection with acknowledged types is merely alluded to and the space itself commands the architectural disposition. As Padovan (2002) suggests when describing the Barcelona pavilion '*Mies' pavilion set out to represent no more than* "what it is to make a space"' (p. 111). Any notion of typology was accordingly disregarded in favour of complete spatial abstraction.

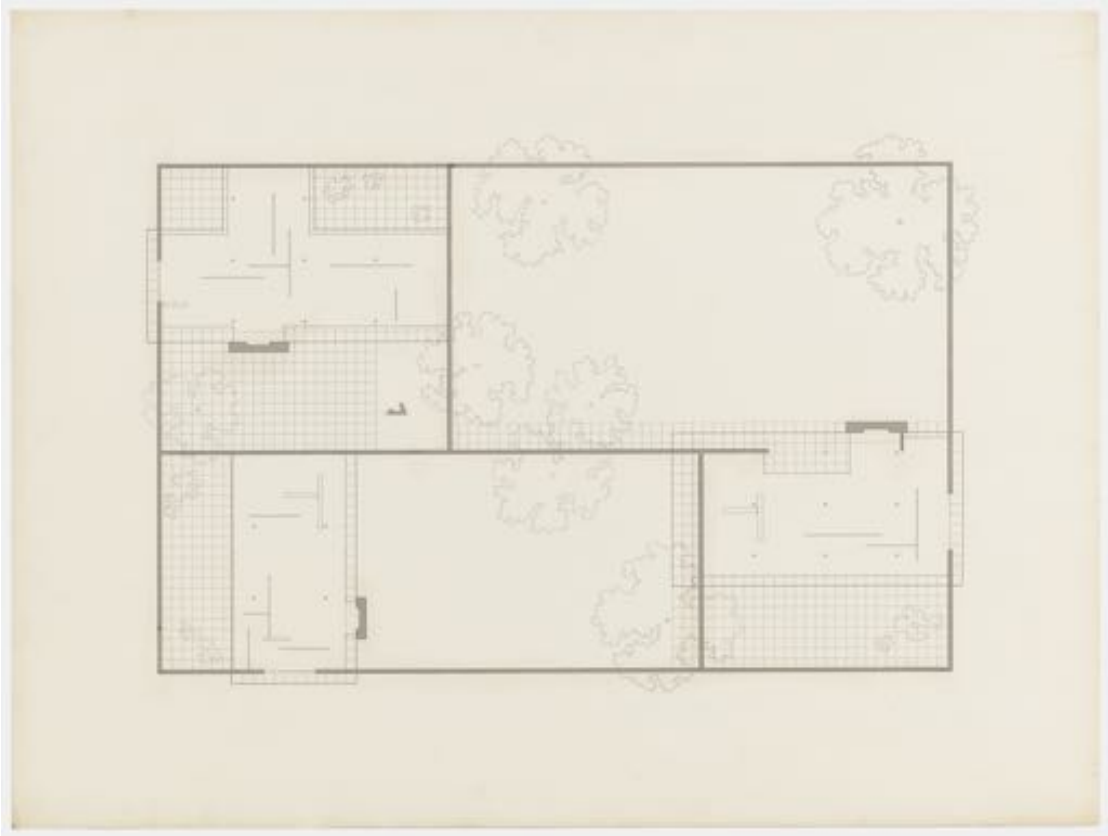
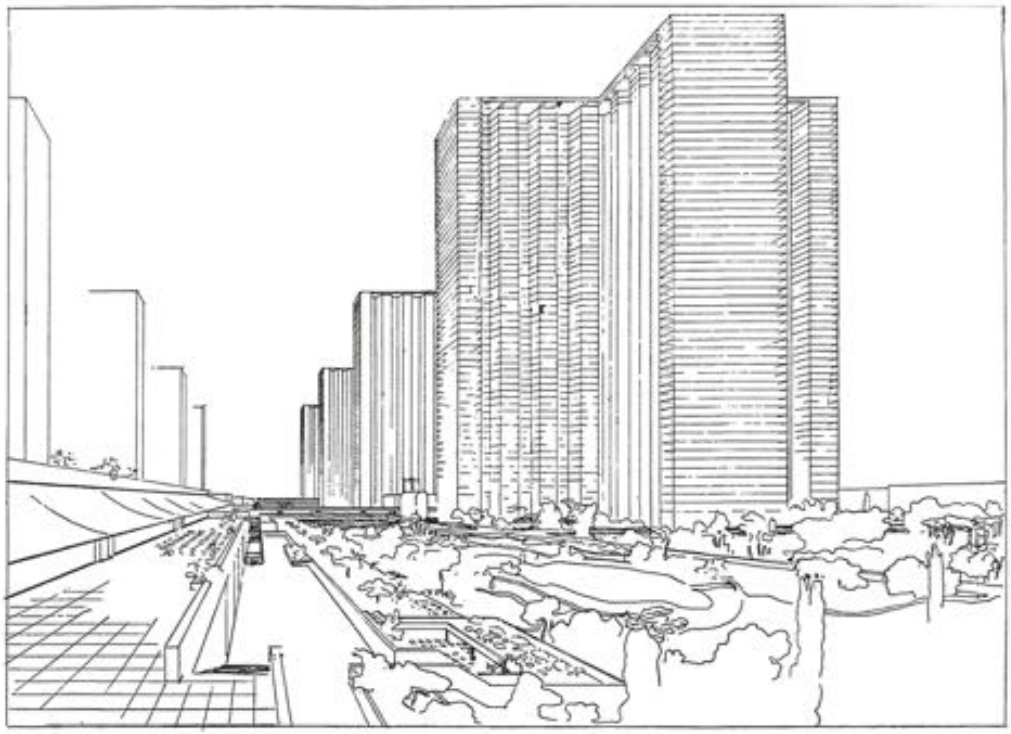


Figure 3.12: Mies van der Rohe courtyard house project (Mies van der Rohe, 1945)

Simultaneously, two powerful ideologies, those of mass production and egalitarian living, underscored modernist prototypical architecture. According to Urban (2013): *'Modernist mass-housing is the most widespread architectural scheme of the twentieth century'* (p. 1). As Moneo (1978) asserts, these ideologies were exemplified in the work of Le Corbusier in projects as the *Domino House, the Plan Voisin, Ville Radieuse* and the *Unité d'Habitation*. As Corbusier (1987) writes in *The City of Tomorrow and Its Planning*, *'as a consequence of repetition, the standard is created, and so perfection (the creation of types)'* (p. 220).



A CONTEMPORARY CITY

The parks at the base of the sky-scrapers. On the right the "set-backs." To the left the receding terraces of the restaurants, cafés, and shops. In the distance may be seen the fast motor track between two buildings, which might well be pure architectural creations.

Figure 3.13: A 'contemporary city' from Corbusier (1987, p. 245)

Lathouri (2011) notes *'it [the typical object] provided a framework for conceptualising architecture as part of a social and ideological agenda.'* (p.25) Such a conception provided a formal link between the individual and the collective where the individual is considered '*typical'* such that repetitive functions may be imposed. The singularity of the architectural object is diminished, thus undermining the very concept of typology, dissolving the boundaries between building, type (the identification of shared characteristics) and typology (the categorisation of these characteristics) and replacing all with single repeatable units. The *type* had become the *prototype*.

Functionalism provided an interpretation of the historical rejection of the modernist agenda and promoted a cause and effect relationship between use and form (Moneo, 1978). As Argan (1963) asserts, industrialisation gave rise to new functional requirements that previous building types were ill-equipped to deal with and the emergence of new types. Conversely building demands that are rooted in the past are seen to risk either typological repetition or the formation of counter types, ephemeral or unacceptable solutions generated by

the designer. For Argan, typology is a value free tool to which suspends historical judgment to critique and ultimately overcome past solutions to allow invention applicable to new requirements. Ironically, the functionalist agenda, revealed the power of types, albeit derived from causal relationships rather than historical precedent. This relationship is apparent in the works of Yorke and Gibberd (1937) in the *Modern Flat* and Klein (1934) in *Das Einfamilienhaus* (Moneo, 1978).

3.1.5 Typology and Process

Within each of the four typological domains there exist associated operations the transform the general to the specific in the architectural design process. Such operations may be understood to define the typology as well as representing the knowledge that may be extracted at each level.

Considering typology as metaphor, the process of transformation from the type to the artefact requires significant translation. For Quatremère de Quincy and Semper, original types are transformed through an inherited cultural language. For Semper this was embedded in tectonics underpinning architectural expression. Rossi, by contrast, derived types as the product of city, and their re-contextualisation necessitates a translation of meaning. Carl's notion of *typicalities* may represent a specific human experience which requires transformation to a concrete condition. Metaphorical knowledge embedded in any type may be cultural (as in Quatremère de Quincy), contextual (as in Rossi's typology) or experiential (as in the *typicalities* defined by Carl).

The adoption of systemic typologies requires a more basic operational system. Organisational typologies can clearly provide structure at a conceptual level however the abstracted nature of the types is such that adaption and development is required. Pierre von Meiss's (2013) typology of plan types, for instance, may provide general physical principles at a conceptual stage but require adaption depending on the specific nature of the project frame. Selection becomes an important operational process, and identification of appropriate systems, connecting the universal to the specific, becomes the determining factor. Knowledge residing in systems typologies may be spatial, structural or organisational but the emphasis is on its universality.

Elemental typologies operate through emulation. Whist again, selection remains important, the typological categorisation is explicit enough to make choice relatively straightforward. In the case of Alexander or Vitruvius, the knowledge of building function defines the choice of type, itself is a pattern for emulation or application. The types are doctrinaire and rule based, thus the skill of the architect is one of artful assembly. Knowledge extraction operates on a functional, visual or technological level.

In literal typologies, translation is absent entirely. The operational mode is one of replication, and accordingly the need to make design decisions is all but removed. Considering architecture as a product there is no distinction between type and object thus the architect's role is one of defining type rather than designing the singularity.

3.1.6 Discussion of Typology

Historical typological theories may be interpreted in terms of a hierarchical structure from metaphorical, to systemic, to elemental, to literal typologies. One must acknowledge the inherent limitations of such an approach. As Pfeifer and Brauneck (2007) note:

'The spectrum of typological examination options ranges from construction details to socio-political interrelations. Typological order, therefore, is no singular phenomenon, but rather it characterises the manifold forms of appearance of the built environment. The complex interrelations between individual elements is re-materialised depending on the respective context.' (p.10)

The balance between continuity and innovation remains a central theme in typological discourse. The modernist inheritance of scientific bio-determinism has manifested itself in automated digital design tools whereby optimized solutions are generated from quantifiable data and unrelated to historical precedent (Colquhoun, 1969). The designer is still left with innumerable possible choices and, combined with the almost unbounded possibilities of construction and design technologies, the reliance on proven design solutions is unnecessary allowing for ultimate personal expression. As Vesely (2004) asserts:

'*Architecture has been confronted with the possibility of design based on an understanding of form, formal purpose, material and technique, whose simplicity and intrinsic poverty are complemented by an unprecedented complexity of personal intentions and formalisations'*
(p. 248).

Vesely's era of '*divided representation'* is one of the opposing domains of science and art, technology and aesthetics, objectivity and subjectivity. Somewhat paradoxically, the objective world is the product of human subjectivity and the more rational our construction of reality, the more subjective the individual becomes in relation to this world. Systematic attempts to order the built environment can be linked to Newtonian synthesis and '*the creation of a closed system of knowledge'* (Vesely, 2004). The emancipation of mathematical science from the natural order heralded an age of *'divided representation'* whereby *'the world of science – the real world – became estranged and utterly divorced from the world of life which science has been unable to explain'* (Koyre from Vesely, 2004, p. 254). Such a division inevitably posed a problem for architects attempting to bridge the dual reality of the synthetic Newtonian world and the practical one. As such efforts were made to develop scientific methods and aesthetic rules to transform inherited architectural principles. The implied division of humankind from the natural order created a perceived control of creation through rational and scientific thought. New systems were based on *'formal principles outside of history'* and were both self-referential and a *'framework for historical criticism and design'* (Vesely, 2004, p. 254). Consequently, the instrumental mode of production implies a formal autonomy of architecture allowing for the unique aesthetic expression of the individual.

Creating meaning within an objective conception of reality and individualistic social order, thus becomes the intention of the architect. Charles Jencks describes a '*shift from the monument to the icon'* suggesting:

'While monuments before the 19th Century had a clearer set of meanings and iconography, the iconic building now depends more on a set of loose associations than on accepted conventions, more on connotations than denotations.'
(Jencks, 2015).

Jencks, suggests common metaphors now adopted by architects (notably cosmic and natural codes such as that of the crystal or the spiral of the vortex) convey signification through shared stylistic attributes and associations. Type is derived not from a shared architectural language, but as a metaphorical and aesthetic entity which, through usage and association assumes cultural meaning.

Moreover, the very notion of a common heritage may be misleading in a pluralistic society, without the overarching guidance of religious or political institutions. As Moussavi et al. (2014) suggests *'given the absence of shared understanding in contemporary society, it is not possible for built forms to convey meaning through signification.'* (p.37).

The disembodiment of type from its context and its meaning, may prove a useful tool for the architect when generating new design solutions. Despite this, prototypes, stereotypes and elemental forms, fail to acknowledge their embodied cultural associations; they are not used to convey meaning but become abstracted tools for individual design. Carl (2011) identifies the *'tension between the conceptual field for types and the concrete topographies which we inhabit'* (p39). For Carl, types tend to flatten the richness of human experience converting it first to form then to information. Subsequently the ability of a type to encapsulate human experience is compromised through *instrumentalised thinking* (Vesely, 2004). Accordingly, types exist within artificial topographies; systems which are unable to convey the depth of reality. The *'patterned distribution of units/types'* may suggest that types are capable of generating systems, which, as Carl asserts, reduce the possibility of dwelling.

For Carl and Vesely, only a metaphorical understanding of typology seems appropriate, on that capture the full richness of human experience and embeds it in a non-physical entity. Conversely, for Moussavi, systemic, elemental or literal typologies may be of relevance in a world absent of shared value and types may be considered entities *'isolating similarities (categories) from the flux of reality to make purified clusters of these similarities suitable for manipulation'* (Carl, 2011).

3.2 Typology and Design

The complexity of architectural problems and the constraints they are subjected to, make the complete rational reduction of design untenable (Colquhoun, 1969). The designer is ultimately forced to make judgments at some point in the design sequence, previously informed by an appreciation of historical precedent. Colquhoun (1969) suggests the rejection of traditional values had left a void in the design process which has been filled by *'a mystical belief in the intuitional process'* (p. 73) and the genius of the architect.

The inherent risk associated with utilising precedent in design is that of imitation. According to Brawne (2003) our built heritage can never be viewed in its original context nor intended condition making our notion of the past vague. '*The past is not here to be mimicked but to be mined; it is there for our eye to see what may be relevant and to use it as a critical starting point for something new.'* (p. 110). The ambiguity of history acts as a stimulus, rather than a constraint, to the creative designer.

Figure 3.14: Two temples. The Maison Carrée and the Carré d'Art by Norman Foster from Brawne (2003, p. 14)

Existing studies looking at the integration of precedent based knowledge into the design process generally focus on tools for the extraction of knowledge from precedent rather than establishing methodologies that take a holistic typological view of the design process. When considering typology in relation

to the design method, it is useful to consider the broader integration of precedent derived knowledge into the design process. Work has been done investigating case base reasoning in relation to architecture (Maher and Gómez de Silva Garza, 1997, Murbarak, 2004, Eilouti, 2009) as well as in broader fields of design (Kolodner, 1992, Defazio, 2008, Schmitt, 1993). Moreover, computational systems have been examined with regards to integrating typology into the design process (Heylighen et al., 2007, Akin, 2002, Restrepo et al., 2004).

Casakin and Dai (2002) established an interactive system where *'design solutions were associated with relevant visual typologies'* (p. 3). Through a cyclical process between designer and computationally generated typological solutions, the designer was able to focus on abstract knowledge as a means of understanding complex design relationships. This was found to be particularly helpful in clarifying ill-defined problems in the early stages of design.

The Electronic Design Assistance Tool (EDAT) has proved to be a useful resource for making design precedents readily available for usage (Akin, 2002) however their data suggested the system was generally used to corroborate and assess design solutions rather than generate new ones (p.431). Whether this resulted in superior design solutions remained unclear. Heylighen et al. (2007) present a digital similar system (DYNAMO) yet its success was limited by the separation of the technology from the design studio environment and the operational capabilities of the software. The research presents a tool based approach rather than a holistic understanding of the role precedent in the design process. They suggest the potential value of developing strategic frameworks for integration.

Crowe (1984) asked students to engage in typological studies of historic buildings based on contemporary design problems. He found this lead to an expedient method of producing design solutions that could accommodate new, but not unprecedented conditions whilst allowing the transmission of shared cultural values. Moreover it also served to order preconceived notions of precedent, which influence design, and developed the student's self-critiquing skills. The limited availability of typologies assessed however, could restrict the number of viable solutions developed purely from this method.

As Eilouti (2009) has observed, the uptake of precedent based knowledge is more successful in the pre-design phase and can be used to provide clarity to

the original problem. This work was conducted along highly procedural lines whereby participants followed clear, project defining processes. This problem-solving approach to design echoes the sentiments of Simon (1969) as Eilouti notes: *'a design scheme is viewed as an assembly of many sub-systems and sub-solutions'* (p. 366).

Casakin (2004) concluded that metaphorical typologies were particularly effective at the early stage of the design process. In this study the role metaphor is consider in relation to the whole project and its place in the heuristic cycles of the designers is unclear. It is important to note that stimulus was introduced simultaneously to a clearly defined practical brief and so the relationship between the two was important. Casakin (2004) noted the ability of metaphors to shape the project space however this took place in tandem with conceptual expansion of the brief and presumably initial solution attempts.

Akin (2002) surmised that precedents were more often used to corroborate existing designs. Through introducing an electronic database of precedents (EDAT) researchers were able to study how precedents informed heuristic processes of designers. They found: *'[Precedents] supply the criteria for evaluating them [designs]. The active use of a case to generate complete and complex solutions is not supported by our data. This is clearly inconsistent with case-based reasoning strategies that assume that designers do similar tasks manually or have the desire to do so.'* (p. 431)

Clark and Pause (2012) analyse a series of buildings and re-categorise them according to shared architectural characteristics including structure, massing, natural light, symmetry and hierarchy. Aiming to see *'beyond the layers of historical style'* diagrammatic abstraction reveals unexpected families of precedents (typologies); *'a source of enrichment for architectural design'* (p. xiii).

Using pre-defined typological categories may be an expedient method of knowledge extraction however, as already discussed, this pre-classification is limited in scope. Considering the value of precedent at the pre-design phase, defining unique typologies specific to the design problem at briefing phase could be of use.

3.3 Discussion

3.3.1 A Strategic Framework

The variety of historical interpretations of typology suggest whilst there is disagreement on its usage and categorisation, often linked to the prevailing architectural discourse, it has proved a valuable conceptual tool for design and interpretation. Indeed, as Moneo (1978) asserts*, 'the very act of naming the architectural object is a process that from the nature of language, is forced to typify'*. Moneo makes clear the inevitability of typology from a historical interpretive perspective yet its role in the design process is less clear. The process of design cannot avoid typification and embodies a movement from broad principles to specific outcomes.

The logical stage-based models of the design process discussed in chapter 2.2.3 offer strategic shape to the design process, especially when considered structured pedagogies in the design studio. There is an assumed determinism, disregarding the messy and contradictory processes implied by heuristic methods. Their value lies in the structure they offer to these heuristic processes, operating best as normative strategies rather than descriptive models.

Argan (1963) addresses the role of typology in the design process considering the inevitability of typological thinking. *'So that the working out of every architectural project has this typological aspect; whether it is that the architect consciously follows the 'type' or wants to depart from it; or even in the sense that every building is an attempt to produce another type.'* He defines three tiers of types that mimic the design process. The first deals with the complete configuration of buildings (spatial arrangement), the second with major structural elements (roofs, supporting elements etc.) and the third with decorative elements (column orders, ornament etc.). Argan's typologies are independent from classifications of types and allow for any number of variants within typologies, yet they assume a linear design process consistent with stage-based design models.

Rowe (1987) develops a similar hierarchy considering a type as a model, as an organisational system or as an individual element. As a model, the type *'seems to provide for the perceived needs, uses and customs found in the design situation under consideration. For example, a courtyard house, a French hotel,*

or a basilican church may be closely followed in arriving at a design solution.' (p. 87). An organisational typology is used as a reference point for spatial arrangement whilst elemental typologies are examples for solving general problems (such as openings in a buildings).

In both Argan and Rowe's conceptual hierarchies, the literal typology fails to make an appearance. Unlike metaphorical, organisational, systemic or elemental types, the prototypical conception of typology is anomalous in that it undermines the interpretative value of typology. Prototypes are concerned not only with production and thus have limited value in a design framework. Indeed, considering a prototype a typology is questionable; by making reality typical, the abstracted categorisation of the typology has no place.

The value of such a hierarchy lies in the capacity for independent typology formation within the design process. As Rowe (1987) notes *'the particular orientation of the use of typology in design is largely a matter of the moment and the designer's intentions.'* (p.87). The first layer, for example, may embody the geometric formations of Durand, the Platonic forms of Quatremère de Quincy or the social typicalities of Carl. As the design progresses the types become constrained by initial decisions. For example, identification with a certain plan type may preclude a particular structural system which in turn may lead itself to a particular detail solution. Thus through this hierarchy of typology the designer constructs a gradually more specific model and an individual interpretation of type.

Eilouti (2009) developed a hierarchical model of precedent implementation activities in the design process. The model is divided into pre-design, design and post-design phases and suggests how designers utilise precedents at each stage however falls short of offering a taxonomy of tasks at each stage of design.

When considering the role of typology in the design process, a synthesis of typological and a stage process based model of design may offer a normative pedagogic strategy. Such an approach considers a goal orientated approach to design; the development from brief to finished product. The framework considers the stages of the design, the role of typology at each stage and the tasks of the designer. A hypothetical framework is outlined in table 3.2.

Design Stage	Typology	Design Tasks

Frame Definition	Metaphors	Definition of the metaphorical type Translation of written brief Translation of abstract primary generators
Concept Design	Systems	Definition of system types Research and identification of appropriate types
Detail Design	Elements	Establish types for building elements Identify strategies for solving isolated issues

Table 3.2: Typology and a Stage-Based Model of Design

3.3.2 Heuristic Process

The Critical Method provides an activity based model of design processes on the individual and micro scale; decision making within the larger structure of the design project.

Techniques for utilising type with the *conjecture – analysis* process have had little consideration despite offering a strong approximation of the Popperian epistemology. Various studies have explored the introduction of typology at different stages of the design process yet did not consider the effect of typological thinking on the specific stages of CM. It remains unclear whether typological thinking operates at an analytical or a conjectural level. Does an understanding of types inform conjectural processes or is it more effective as a tool to corroborate or deny existing solutions?

Operating within a larger phase based model of design a conceptual framework can be elaborated on which includes the heuristic processes of the designer in relation to a typological structure. A theoretical typological model may consider conjectural activities and analytical tasks that operate at each phase. As the project frame takes on definition, the issues the designer is faced with change and the design activities adapt accordingly. The nature of conjectures maps that of the overall design process, the movement from the abstract to the concrete. The purpose of analysis also changes; to inspire and guide in the early stages; and increasingly informing and verification as the project frame takes shape.

4.0 METHODOLOGY

4.1 Epistemology and Research Paradigm

Guba and Lincoln (1994) discuss the competing paradigms in qualitative research and provide a useful framework to consider the research body belonging to the Critical Method. They consider the ontological, epistemological and methodological positions adopted by four competing paradigms of positivism, post-positivism, critical theory and constructivism (see table 4.1).

Item	Positivism	Post-positivism	Critical theory et al.	Constructivism
Ontology	Naïve realism – 'real' reality but apprehensible	Critical realism - 'real' reality but only imperfectly and probabilistically apprehensible	Historical realism – virtual reality shaped by social political, cultural, economic, ethnic and gender values; crystalised over time	Relativism – local and specific constructed realities
Epistemology	Dualist/objectivist; findings true	Modified dualist/objectivist; critical tradition/community; findings probably true	Transactional, subjectivist; value mediated findings	Transactional, subjectivist; created findings
Methodology	Experimental/manipulative; verification of hypotheses; chiefly quantitative methods	Modified experimental, manipulative; critical multiplism; falsification of hypotheses; may include qualitative methods	Dialogic, dialectical	Hermeneutical, dialectical

Table 4.1: Paradigms in Research Methodology from Guba and Lincoln (1994).

McNeill and Chapman (2005) question the opposition of these paradigms suggesting that a scalar approach is more appropriate. At the one end are positivist studies which have low observer participation, high sample numbers and focus on quantitative data. In the social sciences this may take the form of social surveys. As the sample size decreases, researcher involvement increases progressing through methods including structured interviews to unstructured interviews to observation and finally to participant observation which typically involves high researcher involvement with a limited sample size utilising hermeneutical methods (p. 23).

4.2 Review of Research Methods

4.2.1 Existing Research in the Critical Method

The Critical Method is often presented as a descriptive theory of architecture; that is the nature of design is through *conjecture - analysis*. Drawing from Popper's scientific epistemology, which considers scientific validity to be derived from this method, the research presented by Anay (2006b), Hillier et al. (1972), Darke (1979), Bamford (1991) and Brawne (2003) presents the Critical Method as a descriptive model of design. Despite this body of conceptual work, little research has been done in an attempt to verify or falsify the validity of the model, test its representativeness or collect reliable empirical evidence. Limited evidence is presented by Anay (2006a) and Darke (1979) in the form of case-study evidence. Brawne (2003) presents a normative theory of the Critical Method based on participant observation and suggests its efficacy as a pedagogic system.

The various research methods employed by proponents of the Critical Method can be classified based on classifications by Shields and Tajalli (2006) of micro-frameworks understanding research as being explorative, descriptive, gauging, decision making or explanatory.

Study	Research Purpose	Methodology
Hillier et al. (1972)	Explorative	Non-empirical
Darke (1979)	Descriptive	Case-study
Smithies (1981)	Descriptive	Case-study
Faludi (1983)	Explorative	Non-empirical
Bamford (1991)	Descriptive	Case-study
Bamford (2002)	Explorative	Non-empirical
Brawne (2003)	Gauging	Case-study
Anay (2006b)	Explorative	Non-empirical
Anay (2007)	Explorative	Non-empirical
Wright (2011)	Descriptive	Non-empirical/Case Study

Table 4.2: Research Methodologies in the Critical Method

The presentation of the Critical Method as a universal theory of design as advocated by Brawne (2003) and Darke (1979) is questionable. Both researchers adopt a post-positivist stance, yet the case study methodology employed is limited in scope and implies a highly subjectivist and value-mediated approach (evidenced by their choice of case study and mode of analysis). In the absence of longitudinal studies and any rigorous attempt at its

falsification, the Critical Method as a representative description of the design process is questionable.

Wright (2011) describes a normative pedagogic strategy employed at the University of Bath. The methodology is one of logical argumentation and justification of an ideal method however there is little that suggests how it is instigated or any observational analysis. Evidence for its success is provided in the form of enhanced output and student satisfaction. Such an approach may suggest correlation between the application of CM and success in the design studio but without observational evidence, the relative value of the described learning techniques remain unclear.

Research in the Critical Method has largely consisted of a logical argumentation approach, peppered with anecdotal case studies. It lacks robust observational data, conducted in either a natural or structured environment. None of the studies considered demonstrate an experimental, quasi- experimental or participant approach that offer data that corroborates the success of CM through the design process.

4.2.2 Research Methodology in Case Based Reasoning

When considering the role of typology and the Critical Method, it may be useful to consider exemplar studies in the wider field of design studies and case based reasoning. Table 4.3 describes a number of these studies and the methodologies employed depending on the concerns of the study.

Study	Research Purpose	Methodology
Lawson (1979)	Descriptive	Quasi-experimental (n=36)
Morris (1980)	Explorative	Participant observation
Gulgonen and Laisney (1982)	Gauging	Case study
Morris (1982)	Explorative	Participant observation
Waldman (1982)	Gauging	Participant observation
Kolodner (1992)	Descriptive	Non-empirical
Mobley et al. (1992)	Explanation	Quasi-experimental (n=155)
Fang (1993)	Gauging	Participant observation/Case Study
Oxman and Oxman (1993)	Explorative	Non-empirical
Schmitt (1993)	Gauging	Non-empirical
Tice (1993)	Explorative	Active participation
Muller and Pasman (1996)	Explorative	Participant observation
Maher and Gómez de Silva Garza (1997)	Descriptive	Meta analysis
Achten et al. (1998)	Explorative	Non-empirical
Flemming and Aygen (2001)	Explorative	Non-empirical

Lehrdal (2001)	Gauging	Ethnographic
Akin (2002)	Explorative/Descriptive	Participant observation
Heylighen and Verstijnen (2003)	Gauging	Quasi-experimental (n=46)
Murbarak (2004)	Explorative	Participant observation
Restrepo et al. (2004)	Explorative	Quasi-experimental (n=30)
Heylighen et al. (2007)	Explorative	Meta-analysis
Defazio (2008)	Descriptive	Case-study/ethnographic
Eilouti (2009)	Gauging	Participant observation/case study
Tunçer (2009)	Explorative	Case Study/participant observation
Wu and Weng (2012)	Gauging	Participant observation
Doboli and Umbarkar (2014)	Descriptive	Quasi-experimental (n=34)
Gonçalves et al. (2014)	Descriptive	Survey (n=155)
Moreno et al. (2014)	Descriptive	Quasi-experimental (n=73)

Table 4.3: Research Methodologies in Design Methods Research

The absence of truly experimental procedures is evident, and there appears to be little, if no research conducted using random assignment, double blind studies or with significant numbers. Typically study sizes are small from a very limited population (between n=30 to n=155). Often the experiments are restricted by the context of the university department in which they are conducted and the limited pool of participants the researcher is able to draw from. As such, participants often have similar backgrounds, levels of education and experiences particular to the context of the study thus undermining the representativeness of the work.

Eilouti (2009) acknowledges the limitations of the design studio context and makes a number of ontological, epistemological and methodological assumptions, placing the research into a constructivist paradigm appropriate to the very limited number (n=5) participants in the study. Considering the application of a number of models for the utilisation of precedent into the design process, the methodology is a dialectical one, focusing on participant observation to reveal problems arising with the implementation of the design models (p. 360). A similar approach was employed by Tuncer (2009) utilising methods developed in Grounded Theory (Glaser and Strauss, 2009) to simultaneously construct and evaluate the implementation of a precedent based design model.

4.3 Research Methods

Drawing from Guba and Lincoln (1994) and their taxonomy of qualitative research methods, it is imperative that the aims of the research are aligned with

its conceptual grounding and its methodological approach. The post-positivist stance adopted by the proponents of CM, although conceptually robust, lacks empirical falsifiability or representativeness. This is echoed by the case-study value-mediated approach offered by Darke (1979) and Brawne (2003). Nevertheless the Critical Method remains a model of design, even if not universally applicable, and it may form a pedagogic approach as proposed by Wright (2011).

For the purposes of this study, CM is understood not as a descriptive model but a pedagogic tool, operating within a pluralistic and multifaceted architectural culture. It may be used as a framework on which to hang theories of typology, providing a structure that bridges the gap between abstraction and practical knowledge.

4.3.1 A Mixed Methodology Approach

The research utilises various methods, specific and appropriate to the stated research outcomes.

The initial literature-based enquiry adopted a qualitative and interpretive approach with the aim to construct a critical argument based on the relevant literature. From this the conceptual synthesis of the Critical Method and a theory of dynamic typologies was developed as well as pedagogic strategies for implementation and testing. The review consists of two parts; a critical review of design studies and the design process and a review of literature specifically relating to typology and an outline of the major trends in typological theory. The purpose of this review is firstly to construct a rigorous framework to analyse and compare texts and secondly to allow a conceptual synthesis of typological theories and CM.

To complement the conceptual synthesis, the typological framework is tested and developed within the studio environment. Due to the specific nature of the studio, the limited available sample size and the direct involvement of people and pedagogic processes, the study lends itself to a participant observation approach. This falls within the constructivist paradigm advanced by the design studio and the ontological standpoint of the research. A similar approach was used by Eilouti (2009) to test normative typological strategies. Whilst the approach will be primarily qualitative, it does not exclude quantitative methods

and the research will use a combined approach. McClean (2009) operated a similar mix-methodology in his study of studio culture.

4.3.2 Ethical Considerations

The research was conducted within the BERA ethical guidelines (British Educational Research Association, 2011) which outlines a number of ethical principles underlying any research in the field of education. It also follows the ethical guidelines set out by the University of Bath (University of Bath, 2014).

Voluntary informed consent was given to the participants by informing all of the nature of the research before the start of each session in phase 1. In phase 2 of the research, where the participants formed a more active role in the study, each participant was informed verbally and in writing as to the nature of the research, how the information would be used and the anonymity they would receive. In all sessions the presence of the researcher as an overt observer was made clear and were conducted with openness.

Cohen et al. (2000) notes the potential for social research to treat the participants instrumentally (p. 56). The sessions were deliberately made applicable to their design work and efforts were made to ensure the students benefitted from the workshops, both through development of their own projects and personal skills, and detrimental effects were minimised. In the first phase of the study, this was through development of rapid design skills which were designed to apply directly to subsequent projects. In the second study, the workshops were based around studio project work, and related to and were informed, by this. No other incentives were offered as part of the research.

Confidentiality was protected through the anonymous collection of data in the experimental condition. In the design studio, the small group and collection techniques employed meant anonymity was impossible, but confidentiality has been maintained throughout the thesis, with students' names having been omitted from any work or comments presented.

4.3.3 Representativeness, Reliability and Validity

The limited sample size and time frame of the research draw into question the representativeness of the data gathered. This is a limitation of the research and

thus prohibits generalisations about the application of the method. The constructivist paradigm, under which the study operates, however, does not seek to describe general phenomena but develop a valid approach that may be applicable to other scenarios. Moreover, the mixed methodology approach, provides a triangulation of results to support the conclusions made.

The validity of the study was threatened by a number of factors both internal and external which require mitigation at all stages of the research. These are discussed in detail in each phase of the research.

4.3.4 Structure and Implementation of Research

Given the limited resources of the project, producing a valid explanatory study which can assess the role of typology in design in a statistically significant manner, is not possible. An exploratory study, however, which defines the conceptual framework for future research, can be addressed.

The research took a three-phase approach, where each phase was designed to address a specific objective. The three phases are outlined in figure 4.1. Each phase of the research is not to be understood as a discrete sequential steps but rather developing and overlapping studies that are informed and developed by each previous stage.

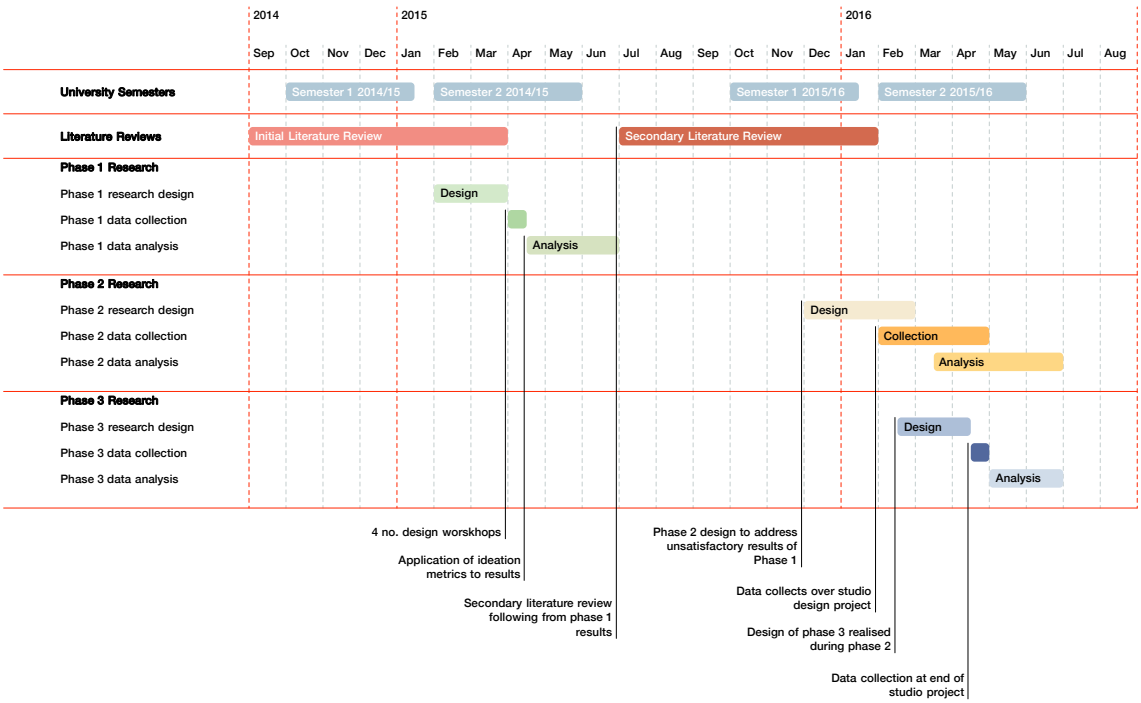


Figure 4.1: Research structure

Research phase 1 addresses the role of typology in the heuristic process of *conjecture – analysis* and asks at what stage in this iterative cycle is typology most effectively introduced. This phase of the research takes a pseudo-experimental approach in an attempt to isolate the factors effecting the design process in novice designers. The research methodology and results are discussed in greater detail in chapter 5. This first phase can be understood as a pilot study and throughout the data collection and analysis phases, significant limitations of this approach were made apparent. This gave rise to and informed the approach for phase 2 of the research. Moreover, the unsatisfactory outcomes of this phase lead to development and expansion of the literature review.

The results of phase 1 strongly informed the design of the second phase, most notably the limitations in the data analysis methods and the lack of nuanced data, partly due to the artificiality of the experiment. Research phase 2 aimed to develop a strategic pedagogic model for the introduction of typology at all stages of the design process, from concept to realisation. A participant observation approach was adopted to explore how strategies and techniques may be employed in a naturalistic setting of the design studio, discussed in depth in chapter 6.

It became apparent during the collection and analysis of phase 2 that a third research phase may help assess the value of the established pedagogic framework in the studio environment. Phase 3 compares the framework with the observations of a control group of students. This was conducted through questionnaires and is considered in conjunction with phase 2 to offer a mixed methodology approach. The approach, methodology and results are presented in chapter 7.

5.0 RESEARCH PHASE 1: TYPOLOGY AND THE CRITICAL METHOD

5.1 Introduction

The first phase of the research focuses on the effectiveness of typology as a design tool at different phases in CM. This part of the research specifically addresses the role of typology in heuristic processes, asking at what stage in the *conjecture - analysis* cycle is it most valuable.

5.2 Theoretical Framework

As Brawne (2003) has suggested, the notion of historical precedent is paramount in CM and provides the closest approximation to the Popperian epistemology. Architectural knowledge resides in built forms, precedents and existing urban fabric. Typology may offer a means of interpreting this knowledge.

The complexity of tacit knowledge and architectural problems mean that in reality reframing design situations will not occur from a single identifiable source. Whilst there may be prevailing or overarching conceptual trends, inherent subjectivities of the designer and the multi-faceted nature of designing necessitate a range of techniques. This may pose a problem for less experienced designers as Wright (2011) notes: *'The process by which designs are generated appears ill-defined and quasi- mysterious'* (p.114). However, consciously attempting to construct problem frames using precedent may provide a stronger conceptual and theoretical basis for design (Hillier et al., 1972, p. 1).

Developing the notion of primary generators and interpreting design as a processes of *generator - conjecture - analysis* (Darke, 1979, p. 38) the first phase of the research examines the efficacy of typology at each of these three stages. A conscious attempt to bypass the inherent generators of the novice designer is attempted by asking whether design can be instigated without the presence of a design problem, but rather only a typological stimulus. This is contrasted with the introduction of typology later in the design process considering its efficacy as an analytical tool.

For the purposes of the phase 1 study, a typology is defined as any means of classification of architectural precedent into 'types' based on shared

characteristics. In this sense, it is not absolute (as in Quatremère de Quincy for instance) and there is no one defined method of classification. Borrowing from Rowe (1987) *"the particular orientation of the use of typology in design is largely a matter of the moment and the designer's intentions."* (p.87). Typologies maybe spatial, tectonic, functional, ideological or any other means of defining groups of characteristics manifest in architecture. For the purposes of the study, typology is understood spatially and precedents are categorised through shared spatial characteristics.

5.3 Aim and Objectives of Phase 1 Research

When working with novice designers, primary generators may be abstract, unsophisticated and naïve (Wright, 2011). Phase 1 asks whether the project space can be formed through exposure to types before the introduction of a brief or set of requirements or whether it is more effective as an analytical tool later in the design process of novice designers.

The study has the following objectives:

1. To assess the effect of visual typology exposure before and after the knowledge of written requirements on the design product.
2. To assess the effect of visual typology exposure before and after the knowledge of written requirements from a learner perspective
3. To assess the effect of exposure to different visual typological representations in the design process.

5.4 Methodology

5.4.1 Description of the Experiment

The experiment took the form of a design task to design a simple structure in plan, section and elevation over two-hour period. Participants were given two A3 sheets, each marked with a space for a plan, section, elevation and 3D view. A 1m grid at 1:50 was lightly drawn on the scale drawings to enable sketches to be drawn to scale without the requirement of scale rulers. It was made clear that the design did not have to conform to the grid.

The research was split into two halves. The first exercise was twenty-five minutes long, in which participants were presented with an initial stimulus and

asked, to respond to it in plan, section, elevation and a three dimensional sketch on the sheet provided. The second part of the exercise involved the introduction of a second stimulus (in the form of an additional brief) in which the participants were asked to consider as additional requirements to the initial stimulus and modify or adapt their original design in response it was also twenty-five minutes long. There was no requirement to complete all the drawings and they should achieve as much as they could in the time available. It was made clear it was not assessed and anonymous.

5.4.2 Context of the Study

First year architecture students at the University of Bath after six months of study were participants in the experiment. Participants worked around tables in allocated groups related to the particular briefs they were presented with. This avoided the use of possible additional stimuli in the design process. Whilst talking and discussion was not prohibited, the participants generally worked in silence, partly due to the time pressures of the task.

The experiment was conducted in a closed environment with participants working around shared tables. Each group shared a table to avoid contamination of results between variable and control groups.

Timescale

Phase 1 of the research took place in Semester 2 of the academic year 2014-15.

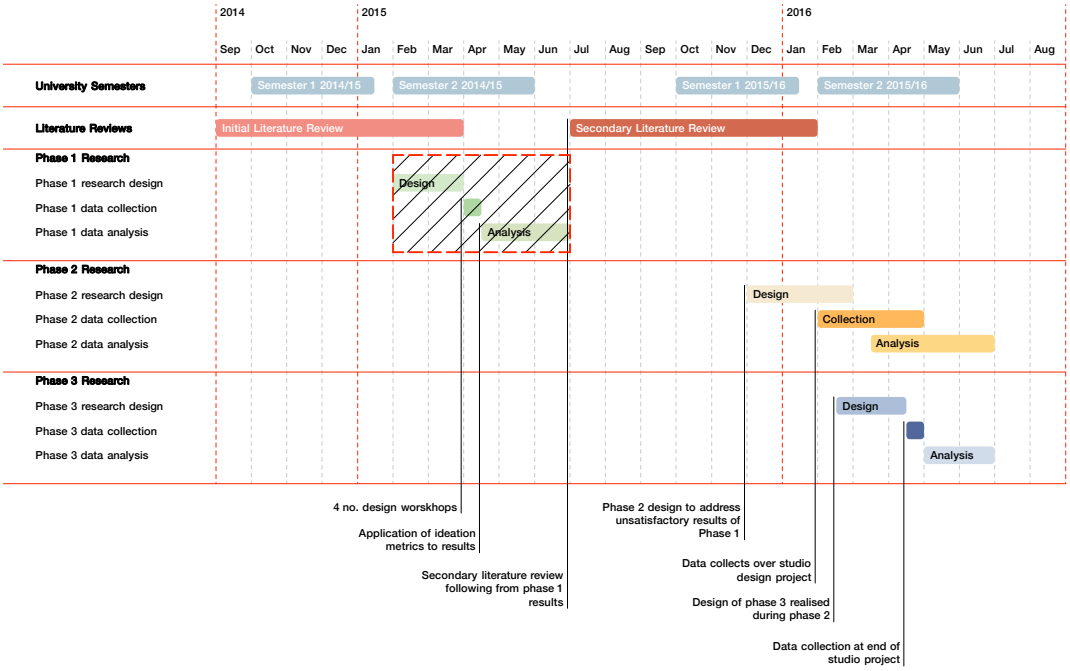


Figure 5.1: The overall research structure highlighting Phase 1

Sampling

The sample selected for the research was the complete intake of first year Architecture BSc students at the University of Bath although 30% of the collected data was disregarded due to inconsistent methodological errors. This sample was considered for both convenience (it allowed a large amount of data from numerous participants to be collected) but also represented a group of participants with similar architectural experience who all had some limited understanding of the critical method. The individual groups were randomly assigned and separated by sitting on different tables or in different sessions.

5.4.3 Parameters of Phase 1

Key parameters in the research are outlined below. Acknowledging these factors, the experiment must be considered in the context of its limitations and the interpretation of results limited accordingly.

Sample Size and Diversity

The participants were all from a single architecture school, of a similar age with similar educational backgrounds (evidenced by the admission requirements at

the University of Bath) and identical levels of architectural education. The teaching paradigm at the University of Bath reflects CM (Wright, 2011) and could be considered typical of a UK architecture school in its emphasis on design studio projects. Moreover, the size of the sample was limited by the size of the studio intake and external resourcing factors. It cannot be assumed the participants were representative of the wider design population due to their specific and limited experience. Thus the experiment can only be considered in this context and generalisation and extrapolation of the results would challenge validity.

Timeframe

The research had a limited timeframe in order to retain a closed design environment to isolated the experimental variables. This meant however, the experiment was not a true reflection of the design process. Typically, studio design projects, take place over a number of weeks rather than hours which may have introduced unnatural and unrepresentative working methods. Participants work at different speeds and may have been affected by time pressure and perceived requirements.

Closed Environment

The design studio is an open environment and students draw from a variety of eclectic sources that affect their design work. In contrast, the experimental conditions were closed and participants were unable to access external resources to guide their process. Whilst this was valuable to isolate specific factors, the experiment must be taken in this context and understood its outcomes may not be generalised to more typical conditions.

5.4.4 Representativeness, Reliability and Validity

Threats to internal and external validity are outlined by Campbell and Stanley (1963), Lewis-Beck (1993) and Bracht and Glass (1968). Internal validity refers to whether the experimental conditions affect the outcome of the study whilst external validity asks whether the results of the experiment can be generalised. The list below is adapted from Cohen et al. (2000).

5.4.5 Internal Validity

History and Maturation

As the experiment took place over a two hour time period within a closed environment, effects between observations were limited to those within the experimental conditions thus preventing maturation of the participants through external inputs.

Statistical Regression

Whilst statistical regression is most marked when there are larger time intervals between pre-test and post-test observations (Cohen et al., 2000), the phenomenon is still applicable and those scored most highly in initial observations are likely to score relatively lower in second observations than those scored initially lower. A regression to the mean could be expected due to the inaccuracy of the data measurement, relatively greater understanding of the task by weaker students in the second observation and environmental effects such as peer intervention. This is a factor that needs to be accounted for when interpreting the results.

Instrumentation Errors

Using assessment metrics that partly rely on observer interpretation introduces a significant level of bias to the experiment that must be accounted for. In assessment, the use of highly structured metrics to assess product is an attempt to mitigate this but the process is still open to both conscious and unconscious bias.

Selection Bias

The selection of students was determined by the first year intake at the University of Bath (90 possible participants) and was then limited to those that were available and volunteered to undertake the experiment (n=59). Whilst this does not introduce selection bias on behalf of the observer, the admissions policy of the University could potentially favour a certain type of student, with a certain educational background and levels of experience. Thus the representativeness of the experiment is limited.

5.4.6 External Validity

Description of Independent Variables

Failure to describe independent variables offers a significant risk to the repeatability of the experiment. These variables are outlined below in detail.

Lack of Representativeness

Generalisation of the experimental data is limited due to the available selection of the participants. All participants had a similar educational level and were of a similar age. They also had 15 weeks of common teaching in architecture which is not applicable to other situations. Despite this, much of the data collected considered the variation between observations and the relative differences between groups. In this sense the commonality of the participants may be advantageous yet it should be accepted that their similar education may make participants particularly responsive to certain learning techniques.

Hawthorne Effect

Participant's knowledge of their role in the research may introduce bias, unavoidable whilst attempting to maintain ethical openness. The original Hawthorne studies (Roethlisberger and Dickson, 1939) was observed whilst studying the effect of lighting on worker's productivity when interpersonal relations between workers and the management were erroneously influencing the experimental results (Wickström and Bendix, 2000). As Wickström and Bendix (2000) have noted, there may have been various other factors that influenced productivity and the Hawthorne Effect may only be applicable in certain contexts. Nevertheless, understanding that the researcher has an impact on the findings must be understood. The use of a control group in the experiment subject to the same observational conditions allows comparison to assess the effect of independent variables.

Ecological Validity

The artificiality of the experimental environment, the contrived nature of the process and the limitations of the study, draw into question the applicability of the process to the actual design studio. The objectives are designed to reflect

this and the experiment is understood to test isolated variables in a controlled environment and not a model of the architecture studio.

5.4.7 Independent Variables

The project was introduced in an identical way to all participants. They were told a friend of theirs was a philosopher and wanted a space to think. They had an abstract plot of land on which to design this space which could take any form as long as it fitted within the site and followed the additional guidelines, presented in the form of single sided A4 design briefs. The different briefs were offered to the students in varying orders. All briefs were presented in an identical way, on white A4 paper (see Appendix A).

- Brief X was a written brief that described the functional requirements of the proposal. It gave a short description of the client (in this case a philosopher who requires a *space to think*, lists the spaces required, details of the site and the necessity to form an introverted environment with a *garden room*. The brief was deliberately designed to imply the creation of a courtyard however this term was not used to avoid any associated connotations.
- Brief A was deliberately blank.
- Brief B consisted of three images of courtyards, from different historical periods and geographic regions (a European monastery, a Japanese temple and an image of a contemporary courtyard by Louis Kahn).
- Brief C was a series of plans of different courtyards at different scales including monasteries, houses and temples.

The different briefs and the order in which they were presented were the independent variables in the task. Within the reasonable bounds of the experiment, all other variables were kept the same. The students were told briefs B and C represented images of the sorts of spaces that their client liked and wanted to create.

Participants (n=59) were tested and presented with the briefs in different orders over two design exercises (figure 5.1).

- Group A were exposed to Brief C (plans) for the initial design exercise and Brief X (written requirements) for the second part of the study.

- Group B were exposed to Brief B (images) for the initial design exercise and Brief X (written requirements) for the second part of the study.
- Group C were exposed to Brief X (written requirements) for the initial design exercise. This acted as a control.
- Group C1 were exposed to Brief X (written requirements) for the initial design exercise (as above) and Brief C (plans) for the second part of the study.
- Group C2 were exposed to Brief X (written requirements) for the initial design exercise (as above) and Brief B (images) for the second part of the study.

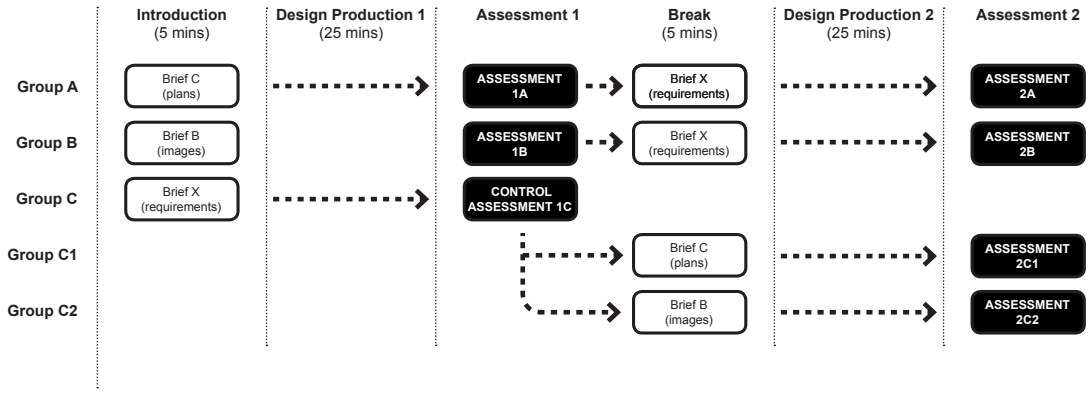


Figure 5.2: Phase 1 Individual session research structure

5.4.8 Data Collection

Two modes of data collection were utilised; the output of the design exercises and direct questionnaire feedback from the participants.

5.4.9 Dependent Variables

Based on ideation assessment criteria outlined by Nelson et al. (2009) and Shah et al. (2003) four metrics were assessed.

Novelty

Novelty assesses how unusual each idea is to an expected norm. Given the explicit nature of the design brief, and the direct relationship between the typological examples and the spatial requirements, a typical response can be generated. Each requirement was considered and possible responses were assigned a novelty score *a priori* (table 5.1). All attributes were weighted equally thus the novelty score could be calculated from:

$$M_1 = \sum_{j=1}^{m} S_{1j} / m$$

Where:

- M_1 is the overall novelty score
- m is the number of attributes an idea has
- j is an individual attribute
- S_{1j} is the novelty score of each attribute

(modified from Shah et al., 2003).

The mean novelty and standard deviation for each group was calculated out of providing a novelty score out of 10.

Attribute	Novelty Sub score (S_1)		
	3	7	10
Relationship to external space	Central garden room	Walled garden	Other
Spatial arrangement	Courtyard	Centralised	Other
Separation from	Internalised	Walled boundary	Other

Table 5.1: Novelty Score Assignment

Variety

Variety measures the extent to which the solution space is explored. As each student is asked to develop and present only one idea, this metric represents variation within the group rather than at an individual level (Shah et al., 2003). The method involves creating a genealogy tree for each set of ideas. The variety is indicated by the number of branches on the tree, with each level on the tree assigned a weighting as one moves down the tree. Developing Nelson et al. (2009) the first branch is defined by general spatial strategies, the second by spatial and site relationships, the third by formal and volumetric manifestation and the fourth by opening strategies, detail and ornament. This was developed from the nature of the brief set and the designs presented. Any number of functional and aspirational values could be assigned to the branches of the tree however this was felt adequate given the scale and sophistication of the explored solution space.

It is important to note that in generating design solutions, some students progressed further than others. As such these designs do not permeate further down the design tree to the detail stage. It is conceivable that designs may

begin from the base of the genealogy tree (e.g. from developing a specific detail or space). Where these are developed but not expanded to a fully developed design, they are assigned a variety score based on how far they rise up the tree.

The variety is calculated by assigning value to the different stages of the genealogy tree where the first stage is worth 10 points, the second, 5 points, the third 2 points and the final stage 1 point. From the refined metrics presented by Nelson et al. (2009) the following can be used to calculate variety amongst a group set.

$$V = \sum_{j-1}^{m} f_j \left(S_1(b_1 - 1) + \sum_{k=2}^{4} S_k \sum_{l=1}^{b_k - 1} d_l / (N - 1) \right)$$

Where:

- V is the variety score for a group set
- S is the score of each level of the tree (S_1 is the first level)
- d_l is the number of differentiations at node l
- m is the number of attributes an idea has
- j is an individual attribute
- b is the number of branches (b_k is the number of branches at level k)
- k is the level of the branch
- N is the total number of ideas in the group set

The formula calculates the average level at which differentiation occurs (Nelson et al., 2009).

Quality

The absence of formal design information, due to the rapid nature of the task, means designs were not developed beyond conceptual stage. This allows an estimation of quality scored out of 10 for each design and then the mean score for the group taken (Shah et al., 2003). Quality was assessed against the requirements in the brief where 5 represented rudimentary fulfilment of the brief and marks awarded for refinement and sophistication.

Similarity

The similarity of designs between the two design phases was ranked out of 10, where 10 represented almost completely identical designs. To achieve 10, 100% of design characteristics were shared and 9 represented 90% of common characteristics.

Student feedback

The limited scope of the deign task, the restricted time and the controlled nature of the output meant that assessment of the task could be limited to the requirements stated in the brief and the structured output allowed the measurement of a number of other metrics. Students' perceived efficacy of the different briefs was also ascertained.

Students were asked to:

- to evaluate their own success at performing the task
- whether the briefs limited their creative process, whether the additional briefs helped their problem solving ability
- whether they feel they would have been able to perform better having received the briefs in a different order
- whether they would have performed better without additional information
- whether the overall task enhanced their ability to generate design solutions

These questions were presented in an anonymous survey, linked to each project, and students were asked to strongly agree or disagree, agree or disagree or if they were unsure to a number of statements.

5.5 Results

5.5.1 Novelty

Table 5.2 shows the mean novelty scores for each set of groups, with the standard deviation in parenthesis.

	Group A (SD)	**Group B (SD)**	**Group C (SD)**	
			C1	**C2**
Assessment 1 1st Brief	**Plans**	**Images**	**Written**	
	4.95 (2.89)	6.86 (2.58)	5.71 (1.86)	
Assessment 2 2nd Brief	**Written**	**Written**	**Plans**	**Images**
	4.86 (2.64)	6.76 (2.31)	5.24 (1.29)	6.19 (2.30)

Individual novelty change	-0.09 (2.33)	-0.10 (2.43)	-0.48 (0.90)	0.71 (2.22)

Table 5.2: Novelty Scores

Students initially produced more novel solutions when presented with typological examples in the form of images (m = 6.86, ρ = 2.58) compared to the control condition (m = 5.71, ρ = 1.86). Being presented with plans initially yielded the lowest novelty score (m = 4.95, ρ = 2.89) and results were most similar to the expected outcome.

The greatest increase in novelty between the design exercises occurred when the control group were presented with typological images following the initial design exercise (m = +0.71, ρ = 2.22). However, greater absolute novelty was observed in Group B the second task, when images then the written brief were presented (m = 6.76, ρ = 2.31). Group A (plans then written brief) decreased in novelty. Figure 5.3 shows an example with a high novelty score from group B.

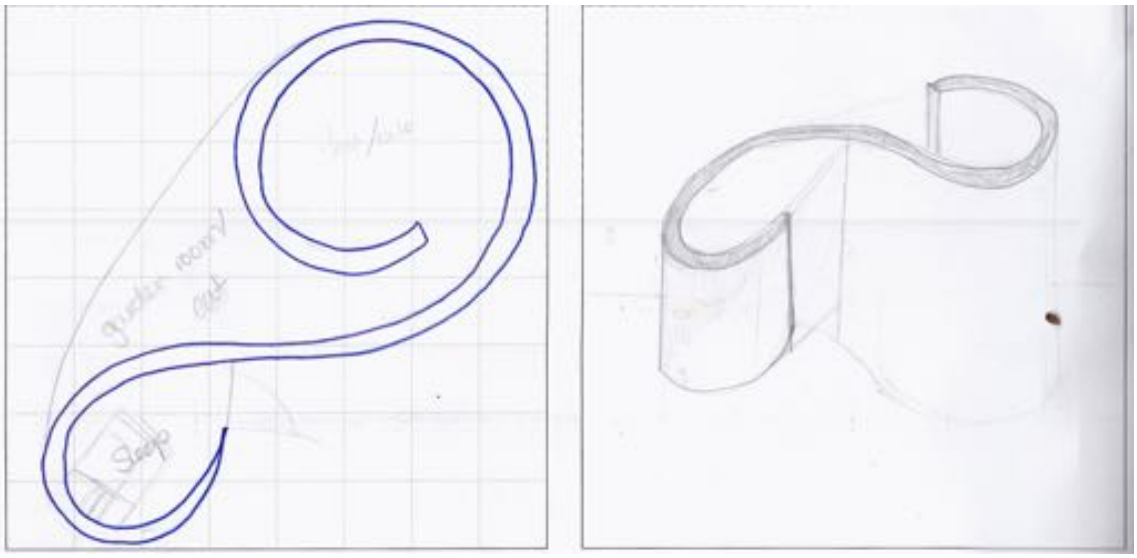


Figure 5.3: A design with high novelty score from group B first assessment

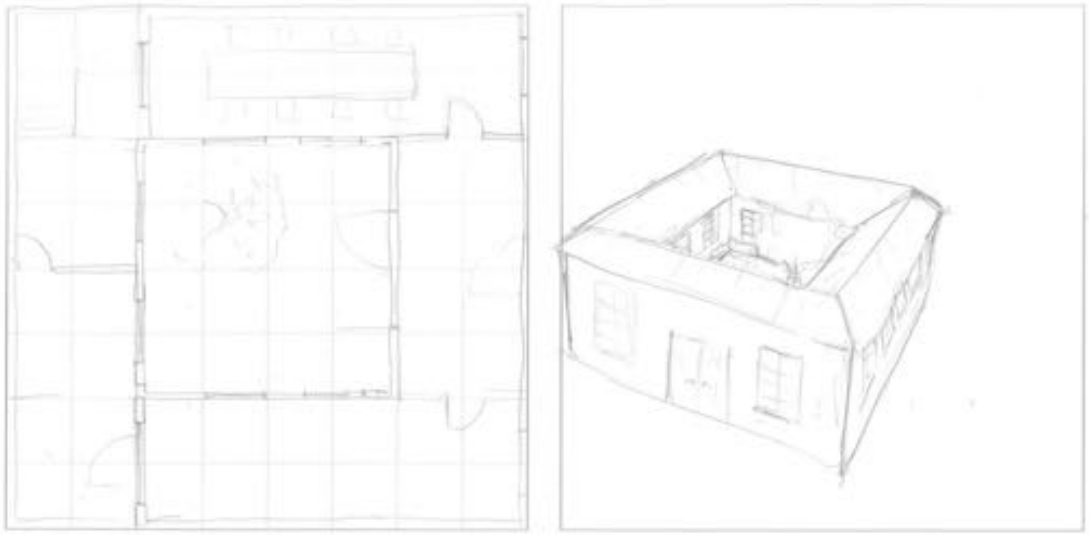


Figure 5.4: A design with low novelty from group A first assessment

5.5.2 Variety

Table 5.3 shows the variety scores for each set of groups. As this metric is assessed as a group and normalised, individual designs are not comparable to this overall score, and there is no mean or standard deviation.

	Group A	**Group B**	**Group C**	
			C1	**C2**
Assessment 1	**Plans**	**Images**	**Written**	
1st Brief	3.90	4.26	5.54	
Assessment 2	**Written**	**Written**	**Plans**	**Images**
2nd Brief	3.81	4.22	5.83	8.33
Group variety change	-0.10	-0.04	0.29	2.79

Table 5.3: Variety Scores

The greatest variety in the initial exercise was seen when students were issued written briefs whilst being exposed to plans yielded less the least variation. This trend continued into the second exercise with Group C exhibiting marked increases in variety whilst additional written briefs yielded no further variation amongst the group.

5.5.3 Quality

	Group A (SD)	**Group B (SD)**	**Group C (SD)**	
			C1	**C2**
Assessment 1	**Plans**	**Images**	**Written**	
1st Brief	5.18 (1.82)	3.42 (1.47)	5.79 (1.85)	
Assessment 2	**Written**	**Written**	**Plans**	**Images**

2nd Brief	5.18 (1.87)	5.33 (1.66)	5.34 (1.29)	6.19 (2.3)
Individual quality change	0.73 (1.88)	1.92 (1.82)	-0.14 (1.21)	0.00 (1.41)

Table 5.4: Quality Scores

In the initial design exercise Groups A and C produced significantly higher quality solutions than group B who were only presented with images (m = 3.42, ρ = 1.47). Improvement in quality was observed in both Groups A and B (those that were presented with the written brief after the initial design task) Neither of the control groups increased the quality of their designs in the second design task however the mean of this metric was higher in both groups C1 and C2 (m = 5.34 and m = 6.19) compared to both groups A and B. Figure 5.5 shows an example from group C with low novelty but high quality scores.

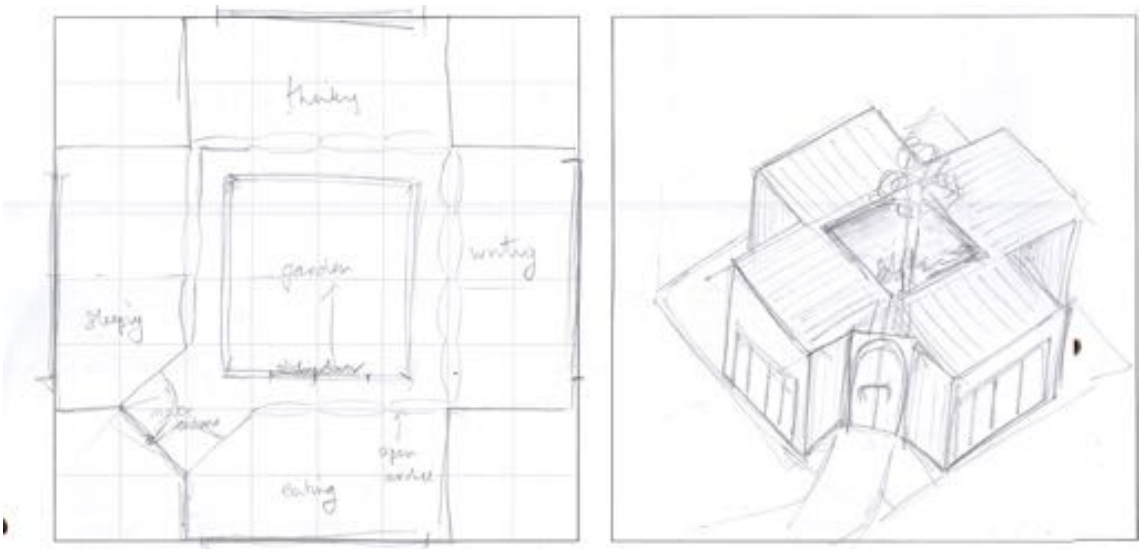


Figure 5.5: A design with low novelty and high quality scores from group C

5.5.4 Similarity

Group A (SD)	Group B (SD)	Group C (SD)	
		C1	C2
Plans then written	Images then written	Written then plans	Written then images
6.77 (1.85)	7.46 (1.74)	6.71 (1.50)	5.71 (3.04)

Table 5.5: Similarity Scores

The greatest similarity of designs in assessments 1 and 2 was observed in group B, who were issued images followed by written requirements (m = 7.46). Conversely, being exposed to images following a written brief (Group C2) yielded the least similarity between assessments.

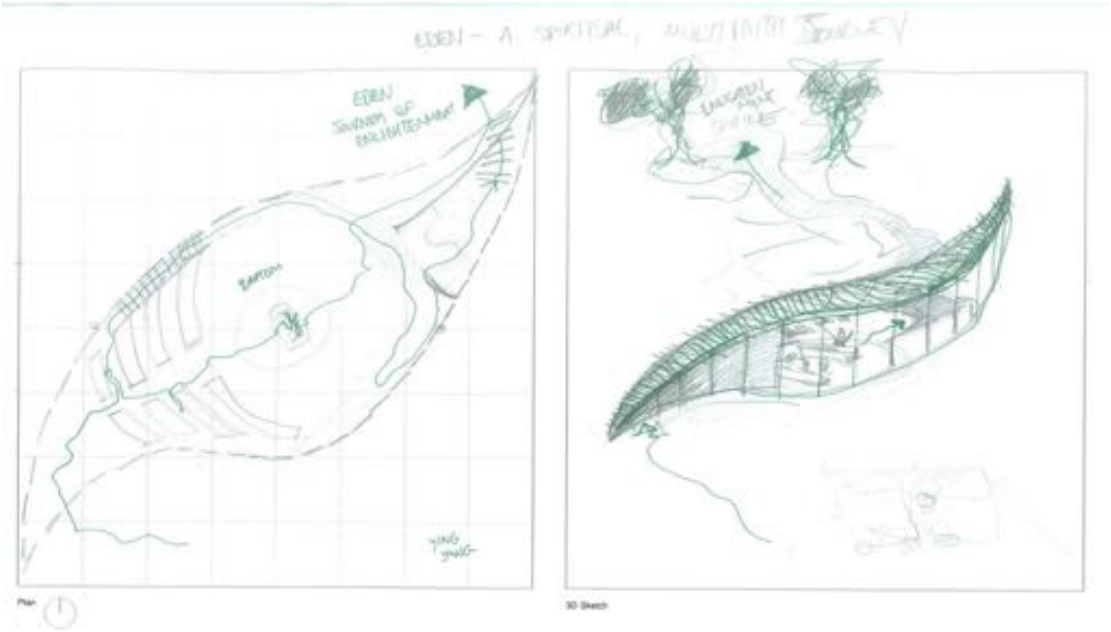


Figure 5.6: Participant from group A showing high novelty and medium quality scores in the first assessment

Figure 5.7: The same participant from group A in the second assessment exhibiting high levels of similarity between the first and second design assessments

5.5.6 Student Feedback

There was very little variation in student feedback between groups. All groups found the visual briefs improved their creativity and helped develop design solutions. The greatest variety was in whether students would have preferred to receive the briefs simultaneously.

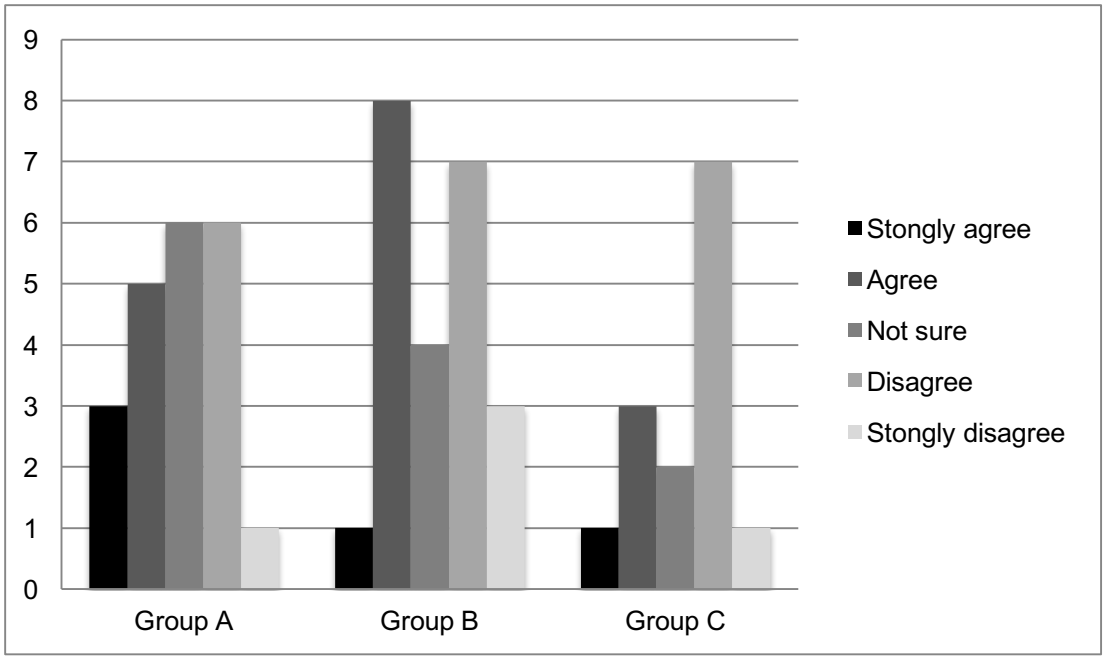


Figure 5.8: Results of questionnaire when asked: I feel I would have performed better having received both briefs simultaneously

Whilst groups A and B were mostly undecided, 57% of group C disagreed with this statement, preferring to receive the briefs in order given (written brief then visual brief).

Groups A and C tended to disagree that they would have performed better receiving the briefs in a different order however in the group exposed to images initially (B) 58% would generally have preferred to receive this later in the design process.

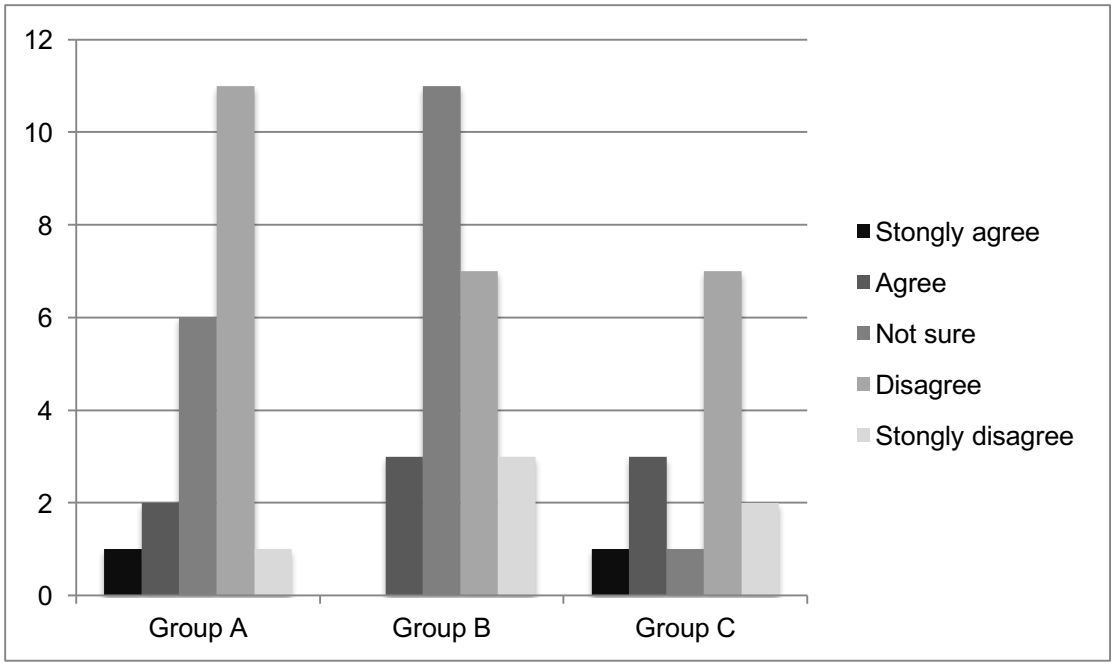


Figure 5.9: Results of questionnaire when asked : I feel I would have performed better having received the briefs in a different order.

The notion of precedents as restrictions on creativity was also questioned and in nearly all instances, participants felt that additional information in the form of typologically arranged precedents enhanced creativity.

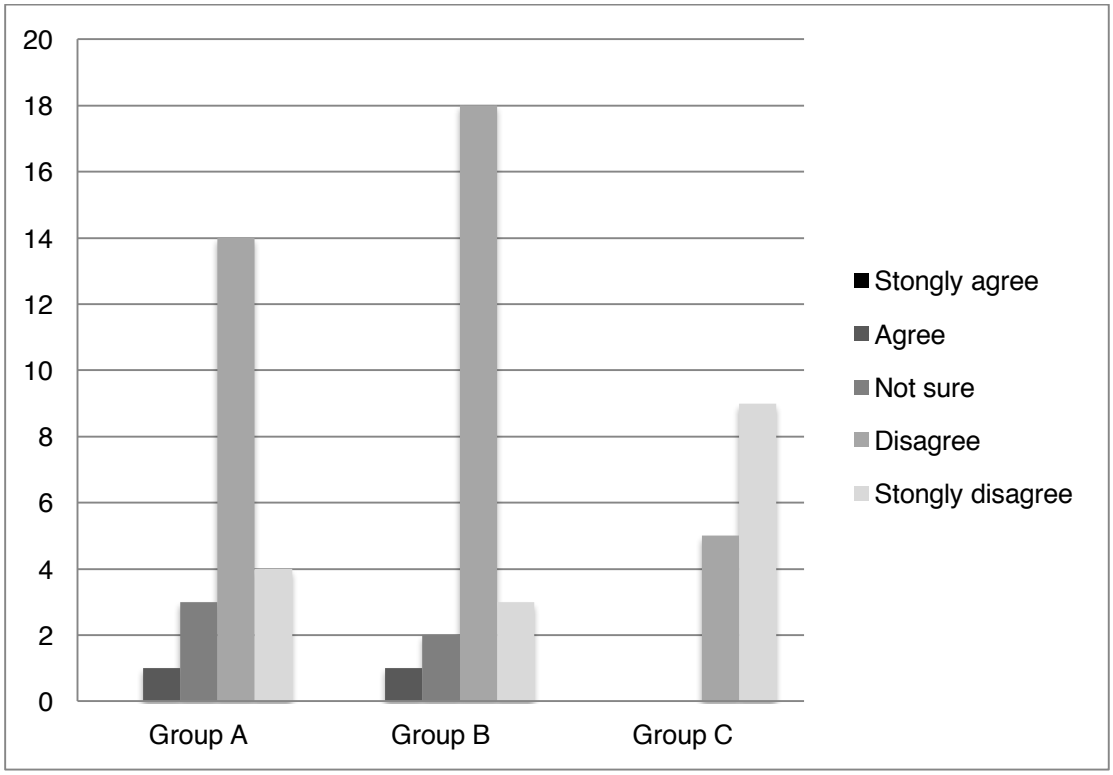


Figure 5.10: Results of questionnaire when asked: I felt the first additional brief restricted my creativity

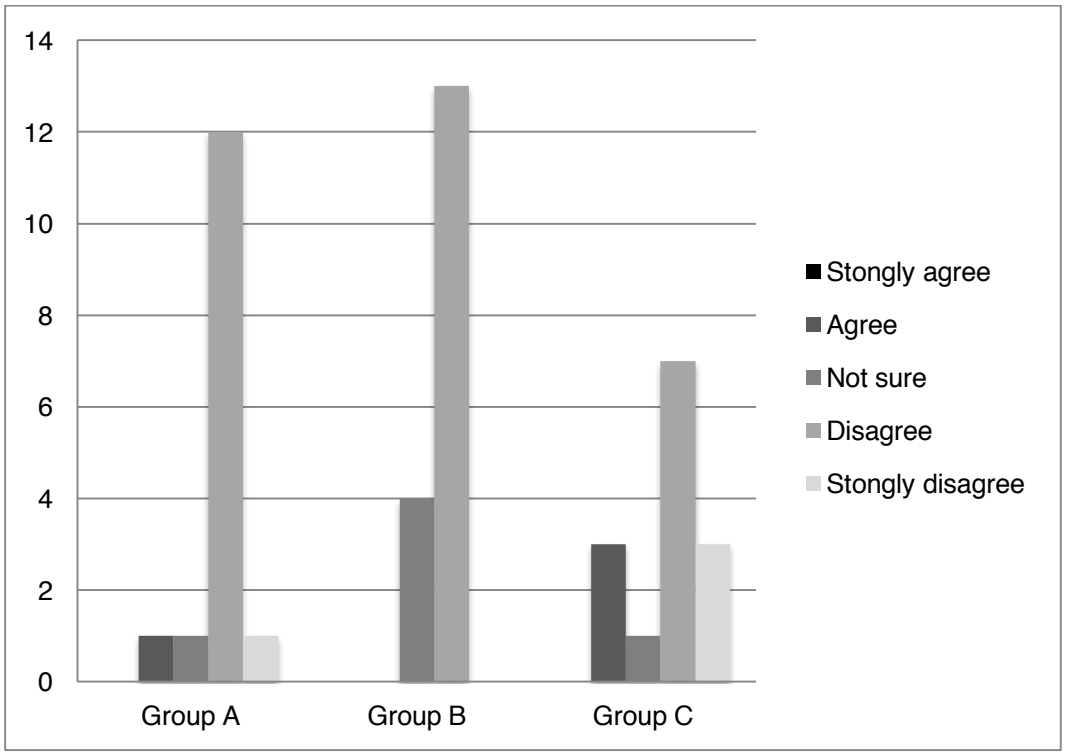


Figure 5.11: Results of questionnaire when asked: I fell the second additional brief restricted my creativity

5.6 Limitations of Research Phase 1

Methodological Limitations

The first phase of the research sought to address the absence of post-positivist, experimental data in studies surrounding Critical Method research. Whilst the results suggest some success, this method has limitations.

The sample of students was from a 1st year students of architecture with the intention of selecting students without highly developed ideation design skills. This sample was deliberate in that first year students were specifically chosen however limited by the resources and timescale of the research to students from the University of Bath. In most cases, the participants lacked the basic skills to perform the task adequately in the time required. Many struggled to produce consistent plan, section and elevational information or lacked the basic drawing skills to do so. Most lacked the ability to resolve a scheme, however basic, adequately in the time allowed.

The artificiality of the setting, limited timescale and lack of external influence also posed a problem for many students. Many suffered from design block or

fixation and were unable to produce designs representative of their abilities. Moreover, the presence of an observer, appeared to exacerbate this and increase artificiality.

Interpretative Limitations

The process of analysis of the results revealed a number of limiting factors that affect their interpretation. Whilst assessing variation in a group, and similarity of ideas was relatively straightforward, the assessment of quality and novelty were more challenging. Quality itself could only be judged through a crude assessment of how well the (often incomplete designs) fulfilled the criteria whilst novelty was assessed against a notional set of expected characteristics determined in advance. The similarity of each scheme to that set of criteria had to be judged by the researcher.

Moreover, the very notion of ideation metrics as an accurate measure of what constitutes '*good'* architecture is debatable. The use of these methods has mostly taken place in the realm of industrial design where desired outcomes are clear and work can be easily judged against these. When dealing with architectural and wicked problems, such criteria does not exist thus making the judgement of quality a challenging endeavor. Furthermore, it is unclear whether variety and novelty should be considered positive characteristics in architectural ideation.

The reliance on student feedback through questionnaire data and assessed metrics left little space for nuanced interpretation of the results. Although students were encouraged to leave comments on the feedback forms, very few did and the comments were often simplistic or rushed.

Research Development

Drawing from the limitations experienced in phase 1 of the research, the second phase addressed these issues by:

- Conducting the study in a naturalistic setting;
- Conducting the study over a longer period of time;
- Developing interpersonal relationships with participants and accepting the role of the observer;
- Adopting a participant observation approach;

- Using a range of data gathering techniques including participant observation, interviews, feedback forms, participant artefacts;
- Using interpretive and qualitative analysis techniques.

6.0 RESEARCH PHASE 2: DEVELOPMENT OF THE TYPOLOGICAL MODEL

6.1 Introduction

The second phase of the research specifically addresses the second and third objectives, that is, to develop a strategic pedagogic model for the introduction of typology into the design process and to assess its value in the studio environment. Moreover, it addresses the unsatisfactory outcomes of the Phase 1 research address methodological and interpretive challenges. The strategic model outlined in the theoretical synthesis forms the basis of this structure.

6.2 Theoretical Background

Considering typology predominantly as an analytical tool in the CM model of *conjecture – analysis* the second phase of the research considers a longer design project over which the hierarchies of typology are considered in relationship to the design process of novice designers. A stage-based model of the design process drawn from work by Tate and Nordlund (1996), Smithies (1981) and Royal Institute of British Architects (2013) amongst others (described in chapter 3) was used to develop a framework for the integration of typologies at different points in the design process. The design process is divided into three distinct phases each linked with a specific understanding of typology:

- Frame definition and metaphorical typologies
- Concept design and systemic typologies
- Detail design and elemental typologies

Independent typology formation is at the heart of this process and the design studio context is considered an optimal context in which to test the model. McClean (2009) has noted the importance of developing independence in the design studio and the framework seeks to provide guidance whilst allowing space for individual heuristic techniques to operate.

Despite the importance of developing independence, Curry (2014) has noted the advantages of utilising structured models of the design process amongst novice designers to provide guidance and shape heuristics and it is against this background the research is to be understood.

6.3 Aim and Objectives of Phase 2 Research

The second phase seeks to develop a structured pedagogic strategy for the implementation of typology into the design studio. Drawing from the results of phase 1, which addressed the most effective timing and presentation of typological information into design heuristics, the second phase considers these issues in a naturalistic environment and aimed to develop a practical framework for its introduction into design studio teaching.

Phase 2 has the following overarching objectives:

1. To develop and test a strategic framework for independent typology formation in the design studio
2. To examine pedagogic techniques for the inclusion of typology into design studio processes
3. To assess the effect of different notions of typology, and associated design activities, throughout the design process

6.4 Methodology

6.4.1 Research Paradigm

The pedagogic technique was developed through prototype implementation of the typological framework using a case-study data from a group of eight students. According to Groat and Wang (2002), cases studies have the advantages of studying phenomena in natural settings, the ability to study causal links, the capacity to develop theory during collection, the possibilities of data triangulation and the ability to create generalisations.

A combination of data collection methods allowed triangulation of results. Participant observation offers the advantages of being able to record non-verbal behaviour or tangible product unlike experimental data. Moreover, this method of collection is less reactive, and may have less inherent bias than data collected in experimental conditions (Cohen et al., 2000). This observational data was supplemented by feedback from participants allowing a triangulation of data to verify observations. Content analysis of an exemplar study was also undertaken to provide a corroborative case-study example.

Following the taxonomy defined by Cohen et al. (2000, p. 186) adapted from Bailey (1994), the research can be understood to have a high degree of structure imposed by the observer with a moderate degree of structure in the observational setting. In the first instance, structured workshops formed the basis of most data collection. In the second instance, the setting was the design studio, using a predefined architectural brief with expected outcomes undetermined by the parameters of the experiment. Whilst a *natural* setting in the context of a student project, there was a degree of influence over the nature of the setting; the group were asked to perform tasks otherwise alien to the design studio and work as a group in an otherwise individual project.

In the constructivist epistemology, there is a subjective generation of findings arising from dialectical techniques creating a specific and relative ontology (Guba and Lincoln, 1994). An iterative process was undertaken, involving a limited number of students and the results of each previous study informed the approach of the next. This took place through a series of structured individual interviews and group workshops over a number of weeks.

Workshops were conducted, developed from this initial level of understanding exploring pedagogic strategies for the implementation of typological theory into the design studio. The intended outcomes of each workshop was clearly defined and made apparent to the participants.

6.4.2 Context of the Study

The context of the study is the design studio which itself informs the methodology of the study. The design studio has its theoretical roots in the constructivist pedagogic paradigm as noted by McClean (2009) emphasising the relationship between the individual learner and the tutor. In this context, knowledge is personal and relative thus outcomes are inevitably subjective and value laden. In this paradigm, a dialectical and hermeneutic pedagogy is taken, epitomised by the 'critique' (crit), jury or review.

Timeframe

The study took place over a ten-week period with 1st year students of architecture at the University of Bath. In this period, they conducted a design project which acted as the overarching context of the study. Four one-hour

workshops were conducted on a weekly basis in which the Typological Framework was developed and data from the students gathered.

This phase of the research took place in the second Semester of the 2015/16 academic year.

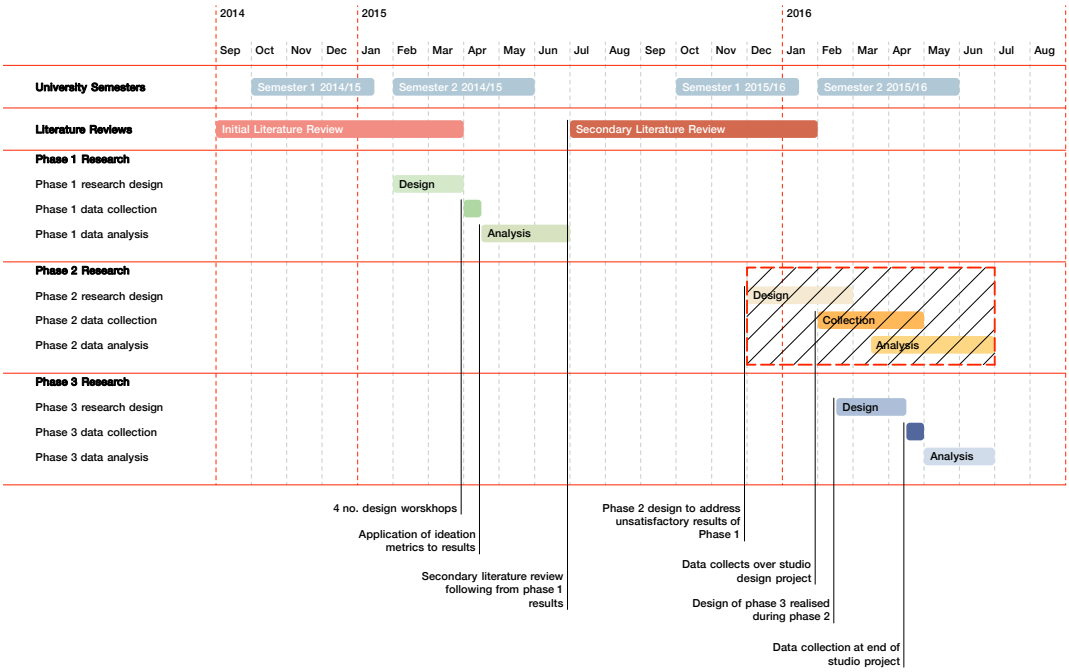


Figure 6.1: The overall research structure highlighting Phase 2

Sampling

The research intentionally adopted a convenience sample of eight students that were randomly assigned to the researcher as a tutor group. Due to the participant observation nature of the research, this allowed the researcher to develop relationships with the students in a tutor and student capacity, mimicking the intended application of the framework. It also ensured the participants were not getting additional teaching or help beyond normal studio hours avoiding potential ethical issues.

6.4.3 Parameters

Key parameters in phase two are outlined below. The participant observation nature of the process limits the extent to which generalisations can be made. Accordingly, the research seeks trustworthiness (Lincoln and Guba, 1985).

Sample Size and Diversity

As in the first phase, the participants were all from a single architecture school, of a similar age with similar educational backgrounds (evidenced by the admission requirements at the University of Bath) and identical levels of architectural education. Moreover, the limited resources available and the specific and idiosyncratic nature of the observation meant a smaller group size was considered. A group of eight students participated in the research, representing the tutor group of the researcher. This was deliberate to allow strong interpersonal relationships to be developed, essential to the nature of the research, and meant prolonged engagement and persistent observation could be undertaken (Cohen et al., 2000). As the study was conducted almost 12 months after phase 1 of the research, none of the students in phase 2 had been involved phase 1.

External Requirements

Conducting research in the naturalistic setting of the design studio meant there was no control over the syllabus and design project which acted as a vehicle for typological exploration. The course requirements the students had to fulfil took priority and as such the application of the typological method was limited. The naturalistic setting, however, allowed for the framework to be developed in real-world environment in contrast to the isolated conditions of phase one.

Timescale

The phase two research took place over an eight-week period. This time period was beyond the control of the researcher as it was determined by the external requirements of the project and the timings of the University of Bath semester.

6.4.4 Representativeness, Reliability and Validity

Cohen et al. (2000) outline a number of possible threats to the reliability, representativeness and validity in mixed methodology qualitative studies. The three data collection techniques are considered for validity.

Interviews

As Cohen et al. (2000) assert, the most practical way for achieving validity in interviews is to attempt to minimise the sources of bias. These might include:

- Attitudes and expectations of the interviewer
- The tendency for the interviewer to see the respondent in his or her own image
- The tendency for the interviewer to seek answers that support his or her preconceived notions
- Misperception on the part of the interviewer of what the respondent is saying
- Misunderstanding on the part of the respondent on what is being asked

From Cohen et al. (2000, p. 121).

As Kitwood (1977) notes, validity and reliability might be at odds in the interview situation. It is the human element of the interview that makes it valid, its interpersonal and idiosyncratic nature, which simultaneously undermines its reliability. A combined method that uses highly structured interviews which allow for expansion and open-endedness was introduced. Whilst it could be argued that this structuring undermines the complexity of the social interaction (Scheurich, 1995), the interviews allowed a comparison of responses to identical questions as well as personal and unique insights.

Observations

The external validity of observational research could be undermined by its idiosyncratic and subjective nature (Cohen et al., 2000). The sampling of the students was randomly assigned by an external agent, however was drawn from the limited pool of 1st year undergraduate students at the University of Bath and therefore avoids observer bias. It's applicability to other situations, however, may still be challenged by its limited size and the results of the study must be interpreted as such.

The internal validity may be threatened by:

- Unawareness of the observer to antecedent events
- Unrepresentative informants
- The presence of the observer

Adapted from Cohen et al. (2000, p. 129)

The structured nature of the research, the formal workshops and controlled methods of feedback and observation, mitigate, to some extent, these effects. The results however can be considered *trustworthy* (Lincoln and Guba, 1985), as opposed to conventionally valid and reliable. To be '*trustworthy'* the study must be considered credible, confirmable, transferable and dependable (Cohen et al., 2000).

Lincoln and Guba (1985) outline various techniques of how researchers may meet the criteria for credibility. Prolonged engagement in the context of the naturalistic study is required to *learn the culture* and test for misinformation, which was achieved through the observer's experience as a former student of architecture, and tutor. Persistent observation describes the need for the researcher to act with salience and openness to identify elements of any situation that may contribute to the issue being examined. Further credibility was given by the data triangulation from multiple sources (interviews, observations of workshops, written feedback, project work), and *member checks* (verification of findings with the participants).

Transferability was achieved through the publication of the presentation of the collected data to allow independent analysis and verification.

6.4.5 The Workshops

Each workshop was designed to map the design process and examine a different notions of typology within the defined framework. As the workshops progressed, the role of the instructor also changed depending on the nature of the typologies. These roles were drawn from the six category intervention defined by Heron (1976) and modified by Yürekli (2013). In the initial workshops the teacher acted as a supporter and catalyst to encourage personal typology formation by the participants and independent project frame definition. In the later stages of the project, when the frame had taken definition, the teacher's role switched to one of informant and prescriber matching the finite elemental nature of the typologies. These roles are set out in table 6.1.

Workshop	Design Stage	Typology	Intended outcomes	Role of Teacher
1	**Frame Definition**	Metaphors	Translation of written brief Translation of abstract primary generators Definition of architectural	Supportive/Catalytic

			model	
2	**Concept Design**	Systems	Definition of system types Research and identification of appropriate types	Catalytic
3	**Detail Design**	Elements	Establish opening and compositional types	Inform
4	**Detail Design**	Elements	Establish opening and compositional types	Inform/Prescribe

Table 6.1: Phase 2 Workshop Structure

Workshop 1

Frame Definition: Metaphorical Typologies

The first week looked to convert initial primary generators in novice designers to independently defined conceptual types. This initial exercise explored the translation of abstract primary generators into conceptual types. Initially students were asked to form and abstract the problem frame, in this case based around the theme of photography. They were then asked, as an independent exercise, to identify ways in which buildings may be categorised. As a group these categories were ordered into typologies and types, facilitated by the instructor. The novice designers were then asked to consider what types of building may relate most closely to their initial abstract concepts. Table 6.2 outlines this structure.

The intended outcome of the workshop was for each student to construct an independent typological frame to act as a primary generator. The identification with typologies also acted as an aid to select relevant precedents for consideration with future design work.

Item	Time	Description
1. Abstract Frame Definition	1 hour	Define photographic theme Sum up in mood board (show example). Combination of images, text, diagrams Identify key characteristics
2. Develop typological categories	1 hour	15 mins: Write down ideas for categorisation on post-it notes. For example, experience, atmosphere, structure, space, colour. Facilitated by instructor. 10 mins: Display post-it notes on board 15 mins: Group organise information into different categories (typologies and types) 15 mins: Choose relevant types based on original themes.

3. Selection of Precedents	1 hour	30 mins: Selection of 5 precedents based on chosen type(s) 30 mins: Each member presents chosen precedents and says how they relate to their chosen type
4. Feedback	15 mins	Complete feedback form

Table 6.2: Phase 2 Workshop 1 Structure

Workshop 2

Concept Design: Systemic Typologies

The second workshop considered Argan's first typological level, that of spatial design. The independent formation of types was developed and students were asked to consider a selection of unfiltered precedents and produce a spatial diagram of each. The group then organised the spatial diagrams into types. The exercise was then repeated with their own initial ideas, each of which was identified with a particular type. The formation of types by the groups was facilitated by the instructor (see table 6.3).

The intended outcome of the workshop was to identify spatial types from a selection of precedents and identify initial ideas with these spatial types amongst novice designers.

Item	Time	Description
1. Previous week's feedback	10 mins	
2. Create spatial diagrams of precedents	20 mins	Each student searched for 5 precedents of their choice (not necessarily related to their project) from unfiltered books and magazines brought in by students to the session. Each student drew a quick spatial diagram of each precedent (instructor presented an example)
3. Categorise spatial types	20 mins	Working as a group, types were defined and the diagrams arranged into these types facilitated by the instructor.
4. Draw spatial diagrams of own scheme	10 mins	Each student created their own spatial diagram relating to their own project
5. Identifying with defined types	20 mins	Each student identified their drawn diagram with a type defined earlier spatial type.
6. Feedback	10 mins	Complete feedback form

Table 6.3: Phase 2 Workshop 2 Structure

Workshop 3

Detail Design: Elemental Typologies

The third workshop was more didactic in format. Participants were presented with a number of opening types and façade composition types and then asked to identify their projects with these types. This method was considered in relation to the independent typological formation of the earlier exercises.

The aim of the workshop was for students to associate their projects with opening and façade types to develop a clear strategy (table 6.4).

Item	Time	Description
1. Presentation of compositional strategies	10 mins	Instructor presents predefined types of composing and considering a façade using precedent examples
2. Identification with compositional strategies	10 mins	Each participant was asked to identify with a particular compositional strategy employed
3. Presentation of opening types	10 mins	Instructor presents predefined opening types within a facade
4. Identification with opening types	10 mins	Each participant was asked to identify with a particular compositional strategy employed
5. Feedback	10 mins	Complete feedback form

Table 6.4: Phase 2 Workshop 3 Structure

Workshop 4

Detail Design: Elemental Typologies

The fourth workshop followed a similar format to workshop 3 however focused around ornamentation and expression of brick (table 6.5). Again a didactic delivery method was used, followed by discussion around each of individual project.

The aim was for novice designers to consider the typological categorisation of brick ornamentation to provide coherent and consistent strategies for progression.

Item	Time	Description
1. Presentation of ornamentation types	10 mins	Instructor presents predefined types of brick ornamentation using precedent examples
2. Identification with ornamentation strategies	10 mins	Each participant was asked to identify with a particular ornamentation strategy employed
3. Feedback	10 mins	Complete feedback form

Table 6.5: Phase 2 Workshop 4 Structure

6.4.6 Data Collection

Data was collected via structured questionnaires at each session, unstructured interviews conducted at the end of the project, participant observation of the workshops and analysis of the completed design projects (table 6.6).

Collection method	Purpose	Description
Unstructured field notes	Observation of workshops	Recording of general observations and key events within the session, focusing on the response to the aims of the session.
Structured questionnaires	Participant response to workshops	Qualitative responses from participants taken at the end of each workshop
Structured interviews	Participant response to overall teaching strategy	Qualitative response from participants taken at the end of the four workshops
Project case study	Analysis of uptake of typological method	Analysis of the design project hand-ins considering the role the workshops have played in the design process.

Table 6.6: Phase 2 Data Collection Methods

6.4.7 Data Analysis

The process of analysis and interpretation was drawn from Groat and Wang (2002) modified from Miles and Huberman (1994) and took the form of reduction, display and verification.

Initially codes were added to the raw data based on the methodology outlined by Miles and Huberman (1994). The coding method initially divides the data into classes based on the three objectives; FR (overall framework), TE (pedagogic techniques) and TY (typologies). Further subcategories were then defined creating data sets. Modifiers were then applied to these classifications based on observations of the data. These modifiers were not analytical but descriptive of the data sets (see Appendix C).

Checklist matrices (Miles and Huberman, 1994) were produced for each objective of the study and considered from an observer perspective and a participant perspective. These checklists were an amalgamation of the four data collection methods, of structured participant feedback, structured

interviews, participant observation and visual evidence (in the form of workshop output and design product) (see Appendix C).

Following the creation of a matrix the analysis draws from the rules of thumb of conclusion drawing of Miles and Huberman (1994). A series of tactics including *'noting patterns, themes; making contrasts, comparisons; clustering; and counting'* (p. 243) were used. This informed written analysis that was then verified through triangulating with the data and confirmation through informant feedback. The analysis process was thus simultaneous with data collection as it informed and directed further research, especially the direction of structured interviews.

6.5 Results of Observation and Feedback

The results were collated, codified and presented in the form of a check list matrix outlining how they addressed the initial objectives of the phase 2 research. They are presented below, considering each objective in turn and considering a number of domains that were observed within each objective arising from analysis of the data.

6.5.1 Results Addressing Objective 1

Objective one was to test and develop a framework for independent typology formation in the design studio. This was divided into a series of subcategories derived from the checklist matrix (see Appendix F).

Hierarchical Typologies and Process

The overall strategic implementation of teaching through typologies sought to mirror the studio design process and it was observed that participants' design processes could be mapped to this structure. Accordingly, an analogous relationship between a logical stage-based model of the design process and a hierarchical understanding of typologies could be corroborated. The non-linear nature of design meant that although students were at different stages in the projects, each could draw relevance from the sessions and all students were able to participate in a meaningful way.

The structure was supported by views of the students. In the interviews participants found value in the changing notion of typology. One student highlighted the different modes of application he employed throughout the design process:

'All the way through I had some strong conceptual, abstract ideas which I used such as 2001: A Space Odyssey. Later in the design process I referred to specific buildings for details and picked and chose elements rather than looking at broad categories of types.'

The participants generally considered the overall structure and strategy of the framework to be successful. As one student put it in the interviews: *'The range of sessions was right for each stage of the design.'*

Some, however, noted that all workshops (especially the final two) could have occurred earlier in the design process. Essential elements of the design (such as the façade composition) should have been 'taught' earlier in the design process and there was a desire for precedents to be 'presented' rather than sought.

Pre-Design and Typology

It was observed that the pre-design workshop was limited in its effectiveness at the time of delivery (simultaneously with the issuing of the brief) and the participants found it challenging to link abstract ideas to notional typologies. A greater level of understanding was observed in later workshops once participants had attempted a design solution to which to relate designs. As one student put it in the feedback from the first workshop:

'Not sure how finding the different typologies/subcategories helped.'

Pre-design workshops were however successful at generating group cohesion, setting the agenda for precedent and typological analysis and encouraged quick decision making, immediately after receiving the brief.

Relevancy and Understanding

As the project space gained definition so did the structure of the workshops and they became increasingly more relevant to the project work. This direct

relevancy however lacked learner defined typologies and so students reverted to the presented types rather than forming their own typologies.

The spatial workshop was deemed the most popular amongst participants in terms of relevance providing a mix between skills acquisition, information gathering and individual relevance to schemes.

"The second workshop on precedents and spatial diagrams as it was good to learn how to zone a building which I felt was the essence of design."

6.5.2 Results Addressing Objective 2

The second objective was to examine pedagogic techniques for the inclusion of typology into design studio processes. Results derived from the checklist matrix are outlined below.

Mapping Workshops to Project Stages

Despite the general success of the framework and the order of its delivery, some issues were encountered mapping project stages to the correct typologies at the correct time. Workshops occurring too close to the end of the project (2 weeks from deadline) were deemed too late to integrate into design by nearly all participants:

'The last sessions were too close to the deadline to fit into the design'

'We only have 1 week – we can't really make changes now'

Pedagogic Style

The workshops took three broad formats; group lead session with supportive tutor role (workshop 1); individual tasks with some group discussion with tutor performing a catalytic role; and presentations by the tutor with the tutor acting as an informer. One issue encountered was that as the project progressed and the participant gained greater understanding, the pedagogic methods became more didactic thus the more challenging, independent sessions occurred at the start of the project when the students had developed the least typological understanding.

It was observed that asking for individual responses in all formats was valuable in revealing inconsistencies in designs and students were made aware of this. Asking how participant's schemes related to the workshop task or presentation provided a useful mechanism to do this and encouraged engagement.

The tutor as supporter was a challenging role as participants often considered the relationship between the tutor and student to be one of imparting knowledge rather than discovering. Early group sessions favoured more vocal, stronger students. Quieter students had to be prompted and the role of the tutor as a supporter was critically important to allow this however there was much stronger student engagement by all students. It was observed group work, although encouraged interaction, left some group members alienated and not participating fully in the task. Some students struggled with the active nature of the first workshop and some found it irrelevant.

'The first workshop was the least helpful as it was not in depth enough and they are things that I would consider on my own'

Others, however, appreciated the changing pedagogic delivery of the workshops:

'Earlier on the more involved and interactive workshops were helpful however the presentations later on were good for dealing with specific problems.'

In instructional sessions, participants were less able to form their own typologies when asked and reverted to the presented types or formed hybrid typologies that related to their projects. Presentations were preferred over finding own examples, partly due to the quality of material offered and the clarity of focus but also the feeling that the students were being taught knowledge. It was observed that presentations and didactic teaching methods offered a powerful mechanism to provide information but did little to engender understanding and participants became rapidly disengaged.

'The presentation [was most useful] as it actually taught me something and helped me analyse my design.'

'The presentations were most useful as they introduced us to knowledge rather than having to find it ourselves which can be hard when we don't know what we are looking for.'

However, participants when interviewed at the end of the project, found the content and the skills learnt in the systemic typologies workshop (diagramming of schemes) most valuable:

'It was useful to know how to draw diagrams of buildings as it makes you think and put into practice. You need to have a diagram in mind when you design and this is something that is useful but not taught.'

Workshop Length

It was observed that the later workshops, which were more didactic in delivery, worked well as short and concise sessions. Students appear to lose interest over longer sessions and variation of techniques was required.

Some participants felt the rapid tasks encouraged quick decision making and creativity whilst a minority suggested that some sessions felt too rushed:

'…because we moved very quickly a lot of information and knowledge was delivered efficiently.'

'It helped me get straight into the middle of the project such that I can get started with coming up with designs straight away.'

'A little more time would have helped [in the first workshop].'

There was also a desire expressed that workshops did not account for variations in participant ability and work pace, especially in the group sessions.

'You have an extremely organised timeline but everyone progresses differently. Perhaps more flexibility.'

Practical Issues

Although not the primary aim of the research, the observations revealed a number of practical issues that must be considered when implementing the typological framework.

For the tutor, it was observed that a significant amount of time outside of the allotted tutorial time was required to prepare each session including research or relevant precedents and the production and distribution of materials. This may have resource implications for the implementation of the framework. Inherent subjectivities of precedent choice and guidance formation could have limited the scope of the designs.

Gauging length of workshop was also challenging. In some cases, participants were able to complete the tasks in half the allotted time (e.g. diagramming precedents) whilst on other occasions they took much longer than anticipated (searching and categorising precedents, for example). It was also observed that students worked at different speeds which occasionally made the implementation of an over-arching framework challenging.

Where the tutor was required to provide significant guidance and act in a supporting role, experience, familiarity with content and skills were required that may make the process challenging to novice tutors.

From a participant standpoint, access to and quality of precedents information produced was of primary importance in all sessions. This was noted in both sessions involve printed material and presented material. Participants preferred high quality images and a vast range of material from drawings to imagery:

'The images of precedents are not in colour which was difficult to look at"

Students also sometimes complained of not being able to see presentations:

"Have people pass round precedents so I can see more in a shorter time"

6.5.3 Results Addressing Objective 3

The third objective was to assess the effect of different notions of typology throughout the design process. Through analysis of the observations,

interviews and feedback as well as the case study example a number of heuristic processes were observed taking place at each stage of the framework.

Within each of the three stages of the design model, a number of operational processes were observed taking different forms at each stage. It was observed that typology generally operated at the analytical phase of CM and that following the conjectural phase, the heuristic process could be broken down into:

- Identification of typologies and formation of types
- Association with proposal and application of type

These processes are discussed in the context of the observed results at each stage of the process below.

Frame Definition

Identification and Formation

In the frame definition phase of the project, it was observed that extracting architecturally relevant characteristics and identifying metaphorical typologies was challenging for most participants. Few were able to make connection between abstract ideas and typical situations or scenarios.

Moreover, the formation of types was challenging to participants. Rather than creating metaphorical categories based on cultural, contextual or experiential phenomenon, when presented with and array of precedents, participants generally ordered them through physical characteristics. Figure 6.2 shows the typological categories formed by participants.

Figure 6.2: Workshop 1 Participant Defined Typological Map

In general, few students formed typologies but reverted to individual examples of precedent to extract metaphorical design information.

Association and Application

Interpretation of written brief acted as a barrier to adopting typologies. Participants were concerned over having the correct brief and complexity lead to tendency to fall back on deterministic methods to interpret and structure the project frame and were unable to associate with formed typologies.

In the completed design reports, there was very little evidence of the adoption of typological metaphors. Mostly, initial ideas were derived from either abstract or deterministic mechanisms. There were of course notable exceptions, and one participant used the typology of a cinema to generate their building concept whilst another used the film *2001: A Space Odyssey* and applied a translation to apply it to his design.

From a student perspective, feedback from the initial workshop suggested there was little understanding on how typologies might inform future work despite it being the clear focus of the session. Most considered the initial design stages about understanding, clarifying and defining the brief through practical and client considerations rather than identifying typologies.

'Learnt how to pinpoint the values of my building which will be important to the design and how they correspond to the user.'

Most students however recognised the importance of framing the project in a consistent manner.

'The purpose of the workshop was to analyse the task thoroughly and thereafter to lay a strong base of the further design.'

The first workshop was considered to be more helpful retrospectively by the participants suggesting they were more engaged with it once they had already begun to design with many students citing the value of typologies and precedent in the retrospective feedback one week after the workshop.

'As we had decided on the precedents and the typology it was helpful for us to start designing the house.'

'It was helpful to explore typological precedents early on.'

Concept Design

Figure 6.3: Phase 2 Workshop 2 Plan Diagramming Exercise

Identification and Formation

In most cases, participants were able to produce simple diagrams of both precedents and their own schemes and they were able to form types. Examples of analysis, presented by the tutor, provided a clear insight into the process and students generally responded by creating similar drawings. The formation of types was led by the facilitator and it was observed participants found it challenging to reduce their scheme to sufficient levels to see shared characteristics with other precedents, although the diagramming process aided this (figure 6.3).

Some participants struggled to create simple diagrams and reverted to literal drawings of plans which made it hard to identify their schemes as types. Again, describing the process of reduction and showing examples of diagrams helped. The diagramming of precedents and individual proposals appeared to encourage analysis beyond an elemental one and towards a systematic understanding aiding rationalisation and resolution of schemes.

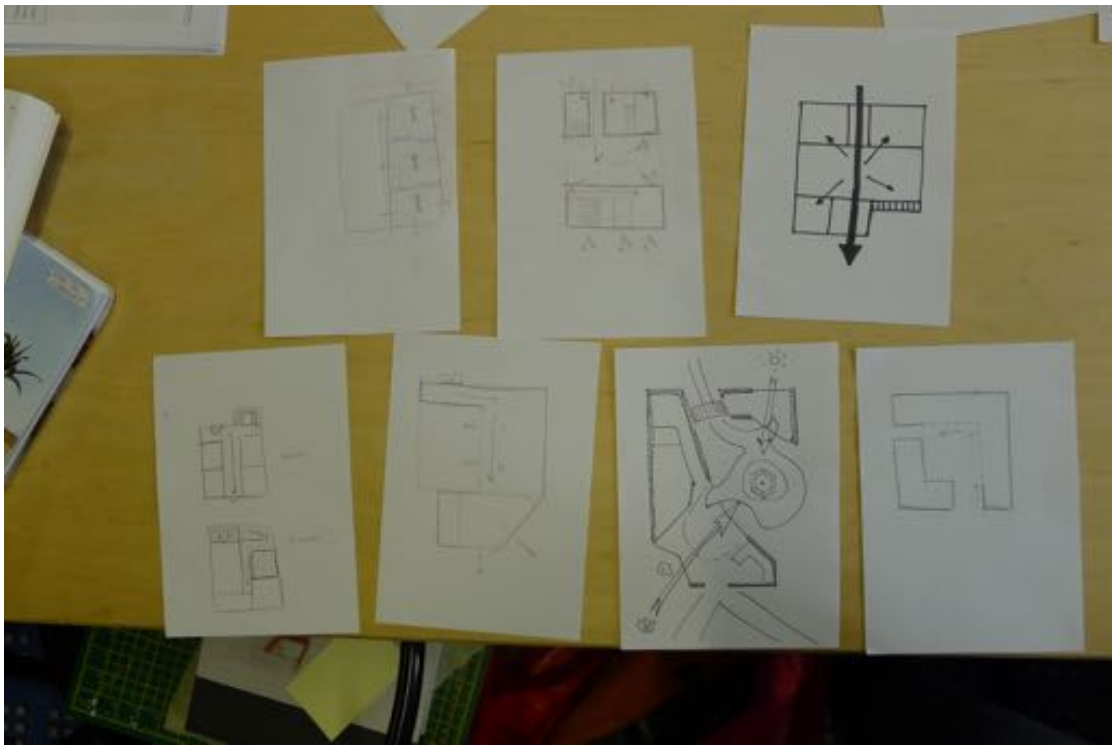


Figure 6.4: Phase 2 Workshop 2 Student Scheme Diagrams

Participants felt creating diagrams of precedents could reduce them to more understandable units.

"It allowed us to think about plans in a simple way"

Association and Application

It was unclear whether participants felt diagramming precedents and forming types could be applied to the design process:

'The purpose of the session was to help us categorise different structural plans.'

Despite the primary activity of the workshop to organise precedents into types, the most cited the purpose of the session to be one of developing proposals:

'The purpose of the session was to get a better understanding of spatial arrangement so that to get a clearer idea of our own plans'

For many, the diagramming and arrangement of precedents into diagrams was almost a practice for their own scheme rather than a means to relate to precedent. Nevertheless, the process of drawing diagrams prompted an abstraction of thought that allowed a detachment from the complexity of individual proposals and allowed participants to develop clarity in their ideas;

'I understand how to simplify a plan to its core principles to help understand why the design works.'

A further effect was that the workshop guided participants to select relevant precedents.

'I selected relevant precedents and understood their basic functions.'

Despite the apparent success of the workshop and its popularity with participants, in completed design reports very few participants exhibited successful application of types despite strong identification and formation phases. Notwithstanding shortcomings in the association through typology, participants were observed to use the process to clarify and rationalize their proposals.

Detail Design

Identification and Formation

At this stage instructional pedagogic techniques were utilised as in most cases a finite number of types could be predefined by the instructor. Choosing

specific elements of a building, there only exist a finite number of ways these might be expressed and due to the restrictions imposed by the over-arching brief, all participants were dealing with similar elemental challenges (details expressed in masonry). In a group of participants with a wider variety of projects such an instructional approach may not have been appropriate. An elemental approach meant all participants could identify with these and instantly spotted relationships to their schemes.

It was observed that all students identified common outcomes of the workshops and found clarity in opening, façade and detail strategies:

'The purpose of the session was to consider different types of openings in our designs.'

Association and Application

In general, elemental typologies were more easily understood and incorporated than more abstract concepts. Elemental types were generally used to corroborate and clarify existing designs or for emulation and replication. Few students created individual typologies but focused on presented types to add clarity to their proposals. Participants valued clarity in presentation as well as the quality and quantity of precedents:

'Clear images and good choice of buildings to get the point across.'

One student who noted its ability to provide purpose and structure when seeking applicable examples for knowledge extraction highlighted the value of typology:

'The presentations [were most successful of the workshops] as they gave clear inspiration which was hard to find on my own when hunting for precedents.'

The presentation of elemental types was understood as an analytical tool by participants and it was generally used to provide a means of comparing individual proposals to types.

'It's helped me to understand what works with my design and maybe what needs to be analysed further. Now I actually understand my design and where to go next.'

'The presentations were most successful as it actually taught me something and helped me analyse my design.'

Evidence from the reports suggest there still seems a predominantly elemental approach to the use of types, focusing on readily available features that are simple to emulate.

There was also a misunderstanding of the notion of typology amongst some participants, perhaps due to the non- explicit nature of the workshops. Nevertheless, this did not act as a barrier to application.

'The windows are aligned in column which is a typology of Tibetan architecture that I want to include in my design'

6.6 Results of the Case Study

Phase 2 of the research yielded a number of design projects and a case study of a successful participant's work is outlined below. The work is described in terms of the stages of the typological framework based on a final submitted design report wherein there was a requirement to describe the design process.

Abstract Primary Generators

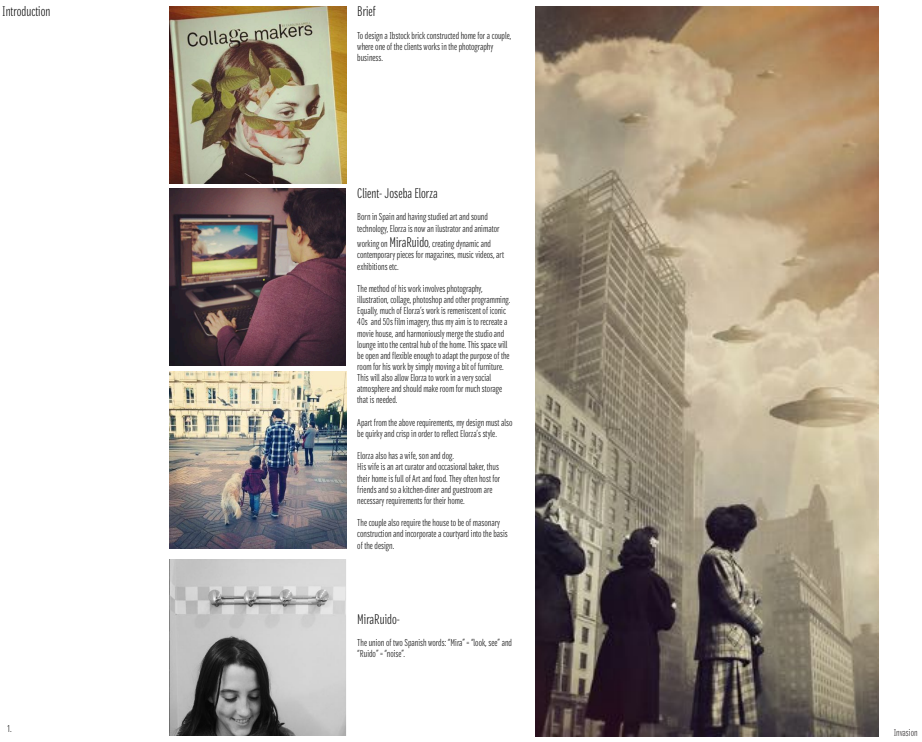


Figure 6.5: Phase 2 case study primary generators

The student began by defining her client and brief, not only practically but also in abstract phenomenological terms. The client selected was a photographer named Joseba Elorza and the student identified key visual aspects of their work, through which a loose project frame was formed. In this case the cinematic quality of the work and the collage means of production. The student identified a metaphorical typology, the movie house, and attempted to link characteristics of the house to this type, suggesting the living space and studio to be merged. This logical gap suggests either a significant amount of design development was omitted from the report or a conjectural leap was made to connect the type with the brief.

Frame Definition

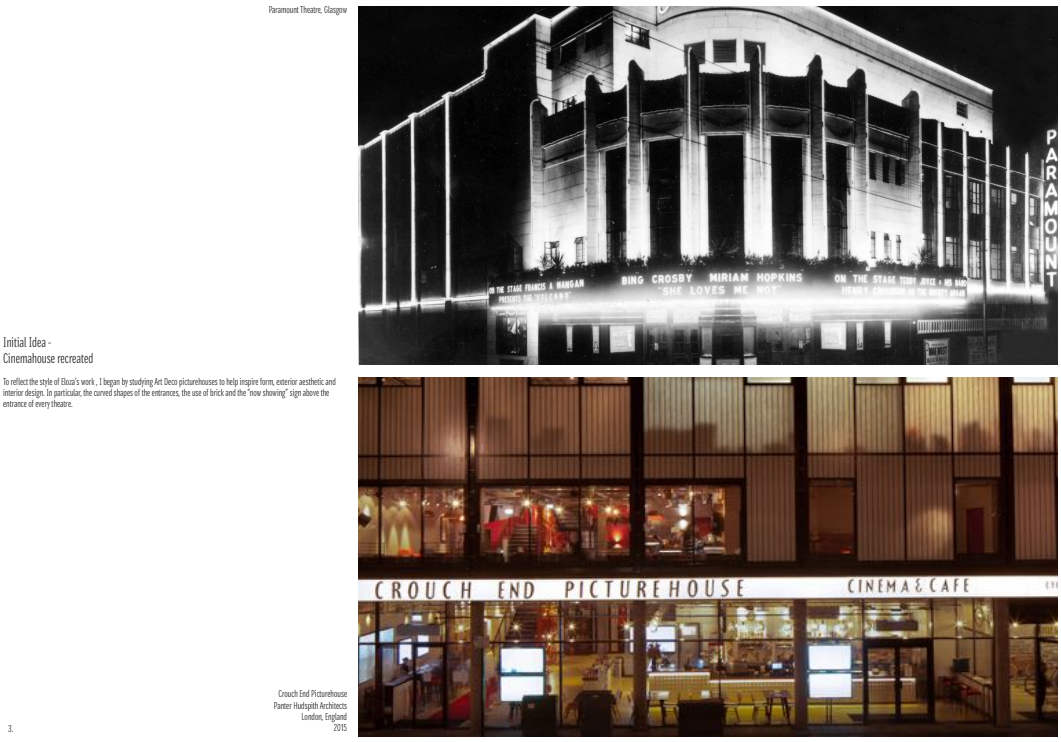
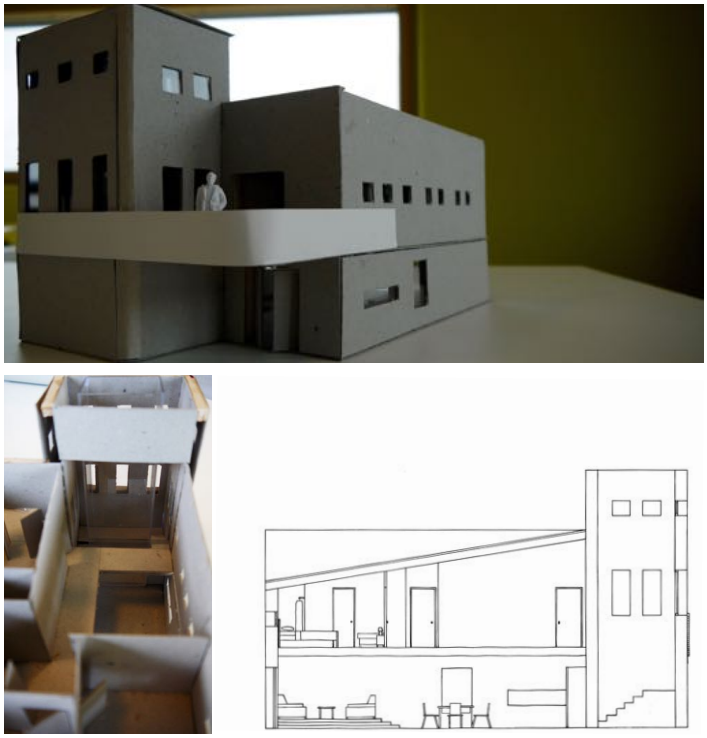


Figure 6.6: Phase 2 case study metaphorical typologies

The student presented further development of the picture house typology and identified formal aspects of the type exhibiting good identification of typologies and formation of types. Moreover she was able to associate this to her initial brief. Her application of the type, however, suggests this was limited to easily identifiable characteristics of art-deco picture houses (the curved shapes and the signage). This demonstrated a relatively low level of understanding of the typicality and a failure to fully assess the cultural and historical factors that define the nature of the metaphor and represents a more elemental approach. Nevertheless, the simple identification of typical aspects of the picture house shows an reduction of precedent to type and the beginning of a translation to the house.



Initial Idea -
Cinemahouse recreated

Features:
-Black brick,
-Recessed windows to create heavy mass and to replicate film reels,
-Balcony constructed of white tiles to resemble the 'now showing' sign,
-3 levels of height and mix of modular adn curved brick to resemble the Art Deco form,
-Stairs wrap around a small courtyard with a tree,
-Ground floor: living/dining
-First floor: sleeping/washing
-First floor cut out to reveal floor below,
-Ground floor is open plan to allow for furniture arrangement and use of space to adapt.

4.

Figure 6.7: Phase 2 case study metaphorical typologies association and application

Initial designs show early attempts to translate the metaphorical type however the bullet pointed text accompanying the images suggests a further elemental approach, breaking down the model type into easily replicable characteristics.

Concept Design

Figure 6.8: Phase 2 Case study systemic typologies identification and formation

After an initial development of the metaphor which was used to construct the project frame, the student focused on conceptual development through more easily identifiable spatial types. Displaying the plans of the chosen precedents alongside imagery shows she was able to identify typologies and however she did not abstract these examples to form relevant types which lead to only a basic level of association with her own scheme. This is reflected in how she applied the design information embedded in the precedents. Further abstraction and deeper typological formation may have encouraged a more successful application of type.

Detail Design

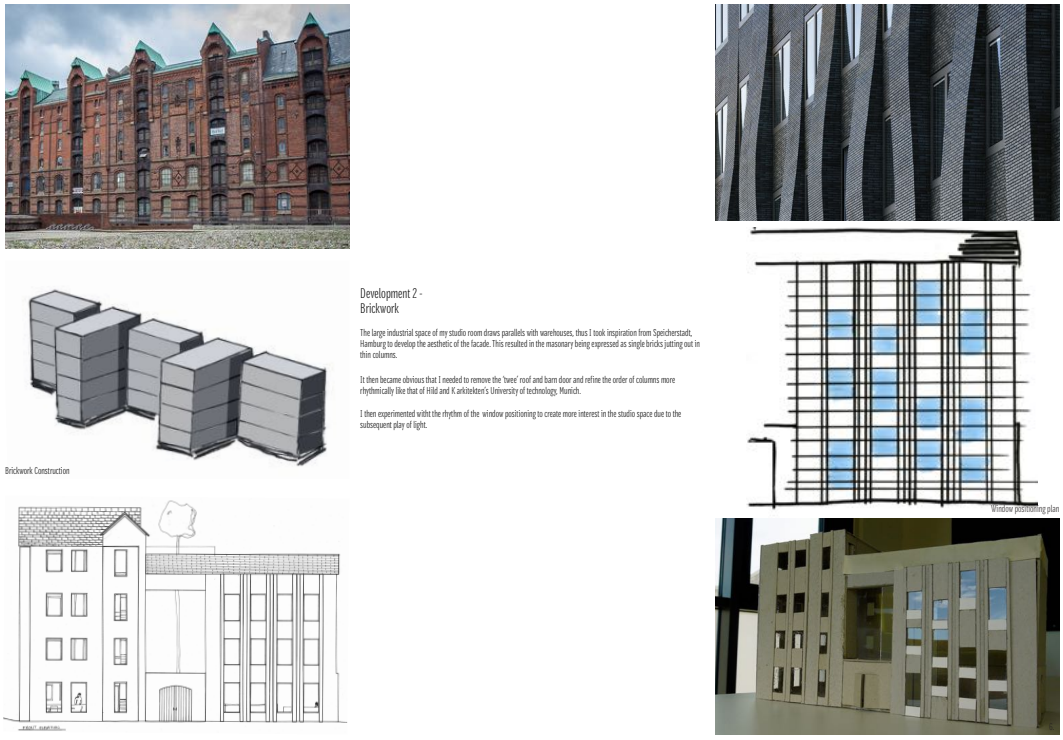


Figure 6.9: Phase 2 Case Study Elemental Typologies Identification and Formation

Figure 6.10: Phase 2 case study elemental typologies association and application

At the detail design phase she was able to identify typologies and form suitable types for application. This included the expression of the brickwork and the windows. The work presented suggests a focus on precedent rather than type,

but the student was able to categorise specific examples into more general axioms. She was then able to associate and apply these to her scheme in a coherent and logical manner.

The student presented their work as a process of *analysis - synthesis* and down played the role of conjecture. Despite this, it is clear from the report that this process was artificial. At concept design phase, the courtyard types were selected based on the initial conjecture of the plan and thus used as an analytical tool for refinement. Likewise, the development of the elevations followed a *conjecture - analysis* process and there was a clear selection of type based on early conjectures.

'The large industrial space of my studio room draws parallels with warehouses, thus I took inspiration from Speicherstadt, Hamburg to develop the aesthetic of the facade. This resulted in the masonry being expressed as single bricks jutting out in thin columns.' (p.6)

In this case it is clear the *'industrial space'* preceded the identification of the type.

6.7 Limitations of Research Phase 2

A number of unpredicted limitations were exposed during the implementation of the second phase of the research. These included both methodological issues and limitations in interpretation.

Methodological Limitations

One limitation observed was the willingness and ability of students to engage with the typological process. Despite being novice designers with little architectural design experience, there was some resistance observed to structured group design sessions and imposed methods between workshop with students opting to dismiss or ignore suggested methods. On the one hand, this highlights the importance of encouraging independent learner discovery in the design studio as noted by McClean (2009) however on the other, draws into question the implementation of structured frameworks in the studio.

Using novice designers as participants in the research may have been one cause of this phenomenon as many lacked the required skill set to adequately implement typological thinking, often struggling with practical problems. Secondly, conducting the research in a naturalistic environment meant the participants were affected by external motivations outside the scope of the research, in this case their desire to perform well on the design task. This undoubtedly had an effect on the motivation for students to adopt a new and challenging model of design.

There existed across the group a mix of abilities which became overtly apparent in the group workshops. Often weaker or quieter students required prompting to engage with the workshops and demonstrated an observed lack of understanding.

Collecting observational data was challenging when attempting to simultaneously conduct the workshops. Moreover, participants often conducted tasks in silence requiring active involvement from the observer to understand processes and methods. This was further confounded by the week long intervals between workshops where no observational data was collected making it challenging to observe the overall effects of the framework. Attempting to observe participants in set tasks and workshops generated an artificial environment where the presence of the researcher may have affected the results. In order to construct a more developed picture of the observed phenomenon, a number of additional observational techniques could have been utilised including the recording of workshops, participant diaries and out of studio observations.

Interviews proved more successful than feedback data from participants, mostly due to the nuanced and developed answers that participants gave. Feedback sheets were occasionally rushed and participants often restricted their commentary to single sentences with undeveloped answers. The interviews proved a valuable tool to probe and fully understand these responses.

Interpretative Limitations

Whilst the first phase of the research focused on design output to collect data, the second phase was more concerned with the student experience and understanding of the typological framework. Adopting a more constructivist

epistemology tallies with the ideological aspirations of the design studio however limits interpretation to contextually specific and qualitative outcomes.

The second phase of the research also lacked any comparative data. Whilst participants were able to judge the efficacy of the framework against their past experience, there was no indication of how this compared to the wider student cohort.

The data analysis method used (coding and a checklist matrix) provided valuable interpretative data however did not provide a means to assess the success of the framework in the wider context of the studio and its ability to enhance design studio product. Moreover, the nature of the method meant through reduction to coded information, general trends were made apparent however outlying or seemingly irrelevant data may have been lost.

Research Development

During the second phase of the research it became apparent that the methodology would not provide a means to understand the success of the framework within the wider studio context. It was deemed that a study comparing the attitudes of the eight participants in phase 2 with the rest of the year group (who had undertaken an identical design project) would be beneficial.

7.0 RESEARCH PHASE 3: COMPARATIVE ANALYSIS

7.1 Introduction

In order to assess the overall efficacy of the typological model, a comparative study was conducted in parallel with the process of development. This compared participants who undertook the workshops with a control group of students who had conducted an identical project but without undergoing the workshops. Identical questionnaires were conducted after the studio project with both groups.

This method, provides a statistical baseline for the study and addresses the wider question of the value of a typological model either as a learning and development aid.

Phase three of the research was designed deliberately to address the shortcomings of phase two of the research, notably the effect of the implemented typological framework on participant attitudes towards precedent analysis compared to the rest of the design studio cohort.

7.2 Theoretical Background

The theoretical background to phase 3 of the research is outlined in chapter 6 and is an extension of the testing of the developed typological framework. This phase of the research utilises a comparative study of the participants in the study group and other members of the same university intake who undertook the same design project yet without exposure to the typological framework.

7.3 Aim and Objectives of Phase 3 Research

The aim of the study was to consider the efficacy of the typological model administered in the second phase from a learner perspective. Whilst much of this was addressed through feedback, observation and analysis in the second phase, a comparative assessment of student attitudes towards precedent, history and typology, in the broadest sense was conducted to ask whether the workshops had produced any significant underlying changes in opinion. Phase three of the research had the following objective:

- To consider the effect on the attitude of novice designers on precedent integration into the design process following the instigation of a typological studio teaching course

7.4 Methodology

7.4.1 Research Paradigm

The third phase of the research utilised a cross-sectional survey technique. This has various advantages of being able to rapidly produce findings, increased cooperation on a one off basis, less susceptible to control effects (the influence of multiple examinations of the same subject to alter results) and being able to operate within the resources of the research (Cohen et al., 2000).

Cohen et al. (2000) also note several disadvantages of the cross-sectional approach including the inability to observe individual growth of participants and the challenge of establishing causal relationships between variables. Whilst a cohort study would have allowed longitudinal analysis and causality to be established amongst variables (the introduction and efficacy of the typological framework) such a study was beyond the scope and resources of the research. Accordingly, the presented findings can only be understood as a limited comparative study between student groups and causal relationships may not be inferred. It does however, provide an insight into relative values of the different groups despite its lack of statistical significance.

7.4.2 Research Design

Questionnaires were sent to members of the study group following the second phase of the research. Identical questionnaires were also issued to the wider year group simultaneously via an online surveying method. The questionnaire was deliberately kept short, with only 7 statements for response, to encourage engagement and avoid fatigue. The questionnaire was based on Likert scale responses (Likert, 1932) with respondents being asked to strongly agree, agree, not sure, disagree or strongly disagree. This allows for more nuanced responses within the context of a comparable scale.

The statements deliberately avoided the notion of typology to avoid semantic bias of the study group who had been exposed consistently to typological terminology. The questionnaire concentrated on aspects of the design process relating to precedent, how respondents went about design and the relationship of the history of architecture to the design process.

The statements posed were:

1. *I prefer to design using only my own intuition*
   This statement considers the notion of primary generators and whether respondents consider the process an internalised one or one drawing from external influences such as precedents.
2. *I use examples of historical architecture as inspiration to help me design*
   This addresses whether respondents tend to adopt precedents within the design process.
3. *I feel the use of precedents restricts my creativity*
   This statement explores further attitudes towards the design process in relation to precedent analysis and whether respondents consider exposure to other ideas limits their capacity for creativity.
4. *When I pick precedents for my work I choose them because they have a similar function to my brief*
   This statement examines how precedents are used by respondents, whether they are chosen for common surface characteristics (such as function) or whether respondents develop a deeper level of analysis and are able to extract a wide variety of design information.
5. *I judge my own work against precedents to help work out when it is successful*
   Comparison with precedents may indicate a wider appreciation of cultural context that shapes and informs a project space.
6. *I feel historic buildings are relevant to modern design and architecture*
   The understanding that new architecture contributes to a continuous historical narrative underlies the use of typology in design. Without this appreciation, the adoption of historical typological models is irrelevant.
7. *I feel my work has a strong relationship to the history of architecture*
   This statement questions how well respondents feel they associate with a wider architectural historical context.

There was a space for comments accompanying each question.

The initial study group of eight students had a 100% response rate whilst there were 22 respondents from the wider year group (a response rate of approximately 25%).

7.4.3 Context of the Study

The survey was conducted following the completion of the final design studio project for 1st year students of architecture at the University of Bath (see Appendix G) in the second semester of the 2015-16 Academic year. The study group had undergone the testing of the typological framework described in section six whilst the control group were sampled from the remainder of the design studio.

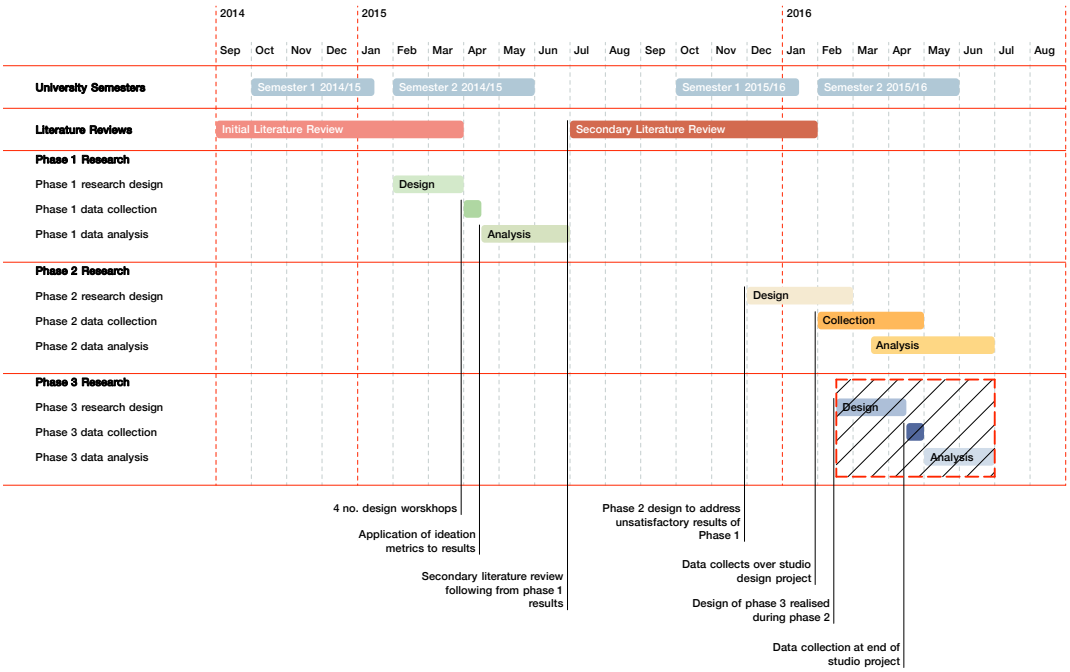


Figure 7.1: The overall research structure highlighting Phase 3

7.4.4 Parameters

Key parameters in phase three are outlined below. The limited sample size, time scale and external environmental conditions (the specific design studio and project) provide the context in which the study must be understood.

Limited Sample Size and Diversity

As in the previous phases of the research, all participants were of similar educational background and stage in architectural career. Unlike phase 2, this could be considered beneficial to the research as it reduces the external variables between respondents of the questionnaires and allows comparative analysis however it limits the extrapolation of results to other contexts.

The questionnaire was conducted online and voluntary and therefore was no guarantee of a sample that was representative of the whole year - group could be gained. The study may be limited to only the most motivated students. This voluntary aspect also reduced the sample size from the original pool of students.

Longitudinal Data

The questionnaire was conducted at the end of the first year of architectural study. Due to the limited timescale of the project, no further questionnaires could be conducted of the same cohort of students and thus longitudinal comparative analysis could not be undertaken, and changes within individual members of the population could not be assessed. The research, therefore, must be understood as a snapshot into the relative values of different members of the intake (those that were exposed to the typological framework, and those that were not).

As already noted, the cross sectional approach does not allow causal relationships to be established and thus the interpretation of results is limited. Triangulation and comparison with the data gathered in phase 2 is thus essential to provide corroboration and support.

Environmental Restrictions

The research is restricted by its own context, that is the first year Design Studio at the University of Bath. Whilst this also serves to limit variables in the data collected, it also significantly challenges the transferability of the collect data.

7.4.5 Representativeness, Reliability and Validity

Cohen et al. (2000) identify a number of threats to validity in the design of questionnaire data. The points below, draw from their analysis.

Problems with Rating Scale

The use of a Likert scale, although attractive to provide nuanced yet graded answers, is open to individual interpretation and the understanding of the terminology may vary amongst respondents. Moreover, it cannot be assumed that there are equal intervals between categories. Quantitative analysis of results is therefore limited to visual displays and non-parametric analysis (Cohen et al., 2000).

Truthfulness

Questionnaires provide no guarantee that respondents will answer in an accurate or truthful manner. As Cohen et al. (2000) note, the researcher may perceive this in an interview or observational setting, however the anonymity of the questionnaire format limits the capacity for this to be detected. Conversely this anonymity gives less incentive for the respondent to lie and in the context of the study it appears there would be little incentive to do so.

Extreme Answers

As Cohen et al. (2000) suggest, there is a tendency for respondents to avoid extreme answers. A five-point scale represents and attempt to balance the provision of a nuanced scale whilst trying to avoid unanswered extremes.

Sample Size

Of the 100 students undertaking 1st year architecture, only 29 responded to the survey (7 from the study group and 22 from the control group). This small sample size makes meaningful statistical analysis an impossibility and the research is limited to a conformational and explorative nature. As responses were voluntary, it is also possible that only a particular type of student opted to respond and may introduce a level of involuntary sampling bias.

Semantic Bias

The notion of semantic bias is to some extent mitigated by the avoidance of specific loaded terms, most notably '*typology'* or '*type'*. The study group's exposure to this terminology would be likely to influence responses and so broader questions regarding the adoption of precedents and the design process were considered. Nevertheless, individual interpretation of the questions provides the possibility for incomparable responses.

Pragmatic Bias

Bias in phrasing of questions was mitigated through the variation of positive and negatively phrased statements in order to avoid leading responses. This also attempted to avoid biasing responses of following questions and over the course of the questionnaire.

Question Type

All statements were offered a '*not sure'* category to allow a neutral or undecided response. Moreover, a comment section was provided to enhance coverage and authenticity.

7.4.6 Data Analysis

The use of a Likert scale and limited sample scale make the quantitative analysis of data limited to non-parametric measures or any techniques based on normal distributions (Allen and Seaman, 2007). Due to the limitations previously mentioned of the Likert system (notably the semi-interpretive nature of the scale, the non-linear differences between choices and the tendency to avoid extremes) graphical representation of frequencies was used for analysis.

Analysis of the Likert data is the cross-referenced with the findings of the other phases and discussed in chapter 8.

7.5 Results

I prefer to design using only my own intuition

The control group exhibited a relatively even split between agreement and disagreement to the statement (46% agreeing or strongly agreeing and 37%

disagreeing or strongly disagreeing). In contrast, a majority of study group (72%) disagreed (or strongly disagreed). Perhaps a telling comment expressed by a member of the study group was the use of intuition was due to a lack of confidence in personal ability rather than a necessary disagreement that intuition is a valid method of design:

'We are only in first year; we don't have enough knowledge/experience and I'm not confident to trust my own intuition.'

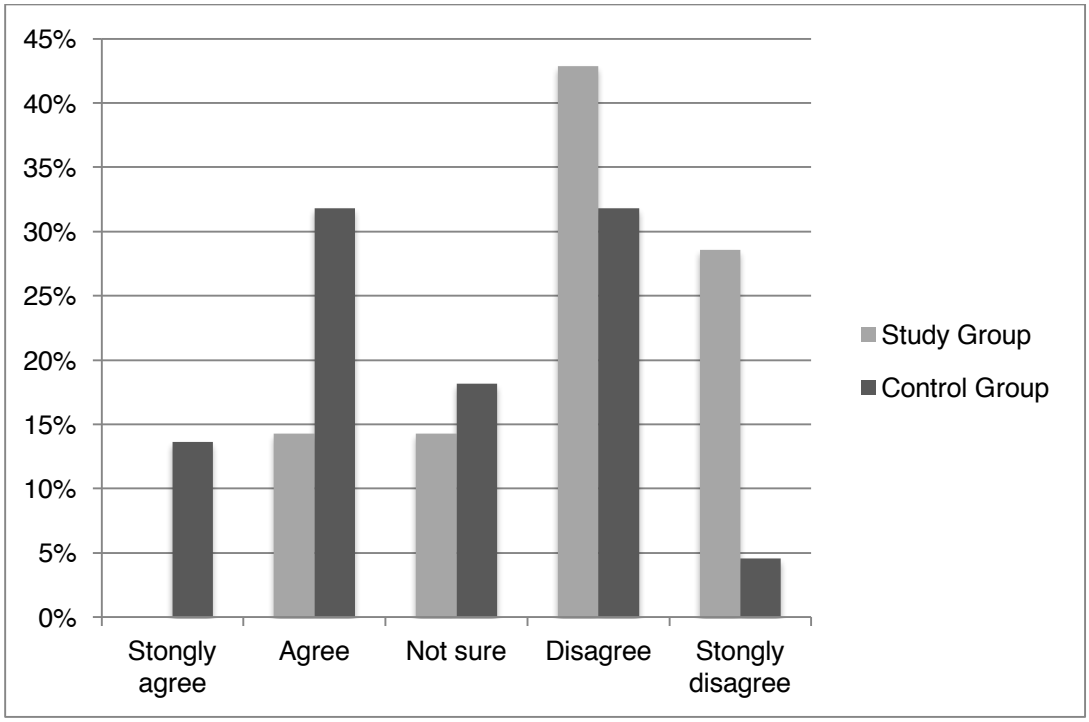


Figure 7.2: Responses to: I prefer to design using only my own intuition

I use examples of historical architecture as inspiration to help me design

A similar distribution of responses was observed between both groups and a significant proportion of respondents (62%) agreed that historical examples acted as sources of inspiration.

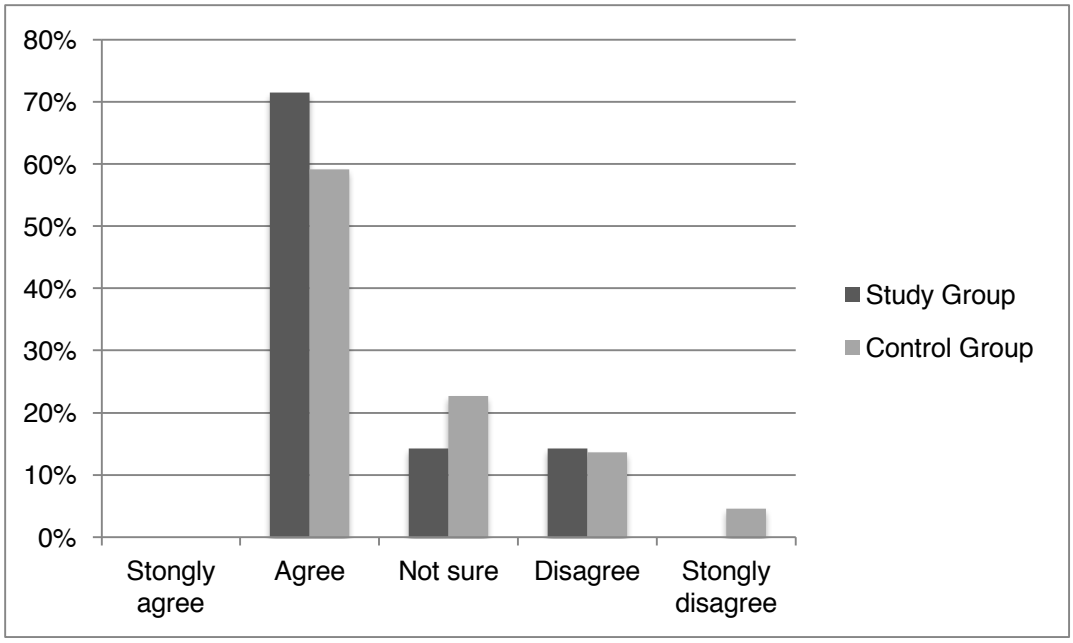


Figure 7.3: Responses to: I use examples of historical architecture as inspiration to help me design

I feel the use of precedents restricts my creativity

Whilst a similar distribution of responses was observed between groups with the majority disagreeing with the statement (76%), it should be noted that none of the study felt that the use of precedents restricted creativity. Despite this, some respondents expressed the possibility of precedent to restrict creativity.

'It can be hard to find originality when using precedents but it only generates more ideas for me.'

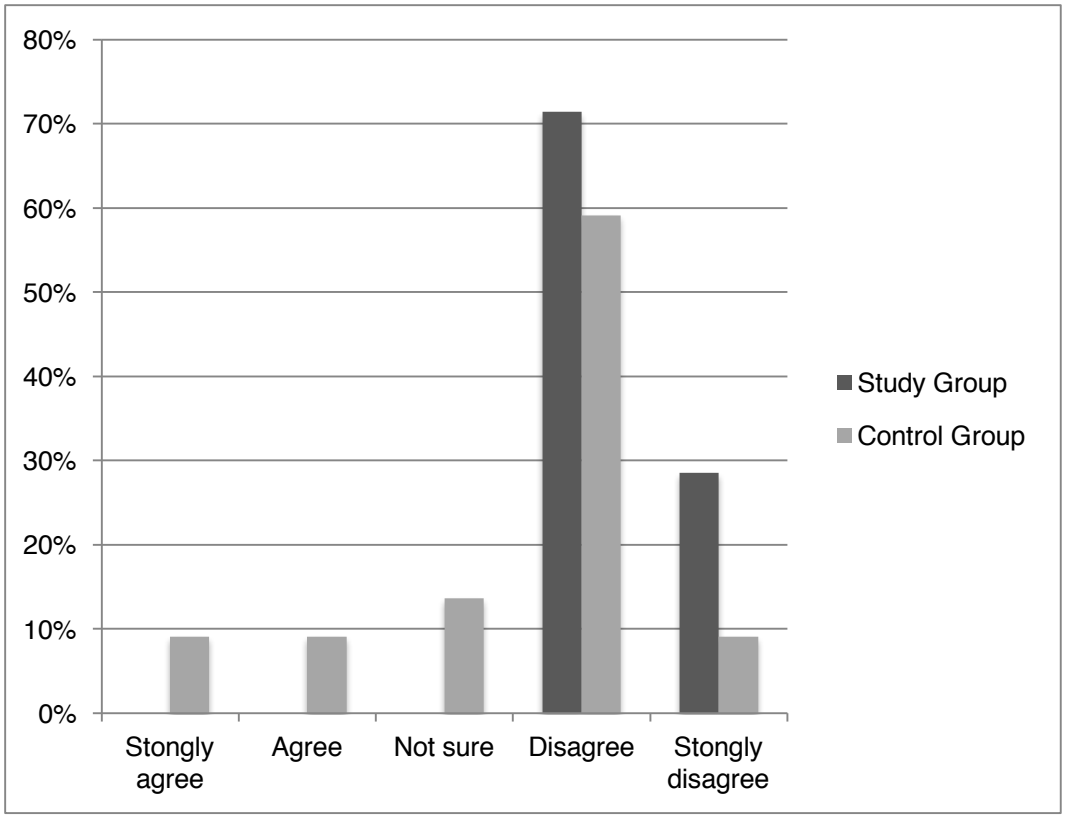


Figure 7.4: Responses to: I feel the use of precedents restricts my creativity

When I pick precedents for my work I choose them because they have a similar function to my brief

A significant proportion of the test group disagreed with this statement (43%) when compared with the control group (9%) although a greater number of the test group also agreed with the statement (57% to 45%). One respondent in the study group commented that *'unrelated precedents make the brief more complicated than necessary.'*

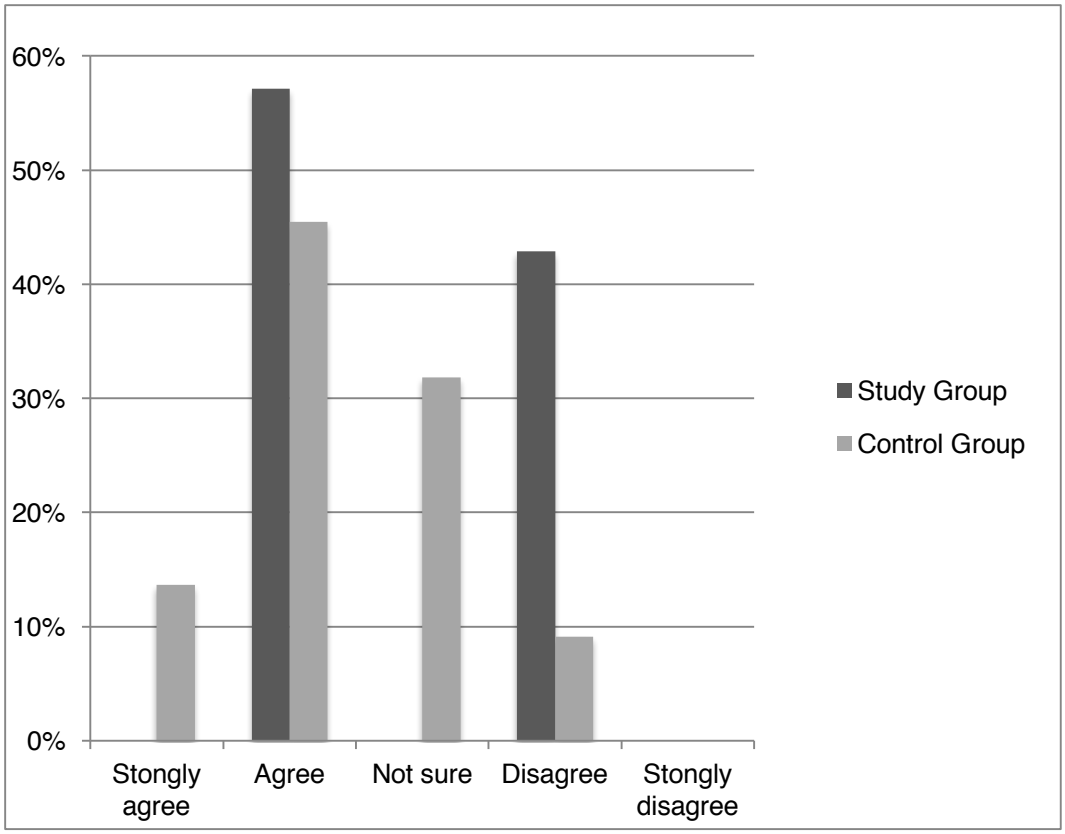


Figure 7.5: Responses to: When I pick precedents for my work I choose them because they have a similar function to my brief

I judge my own work against precedents to help work out when it is successful

A similar distribution was observed in both groups of respondents with 52% agreeing or strongly agreeing, 24% unsure and 24% disagreeing or strongly disagreeing.

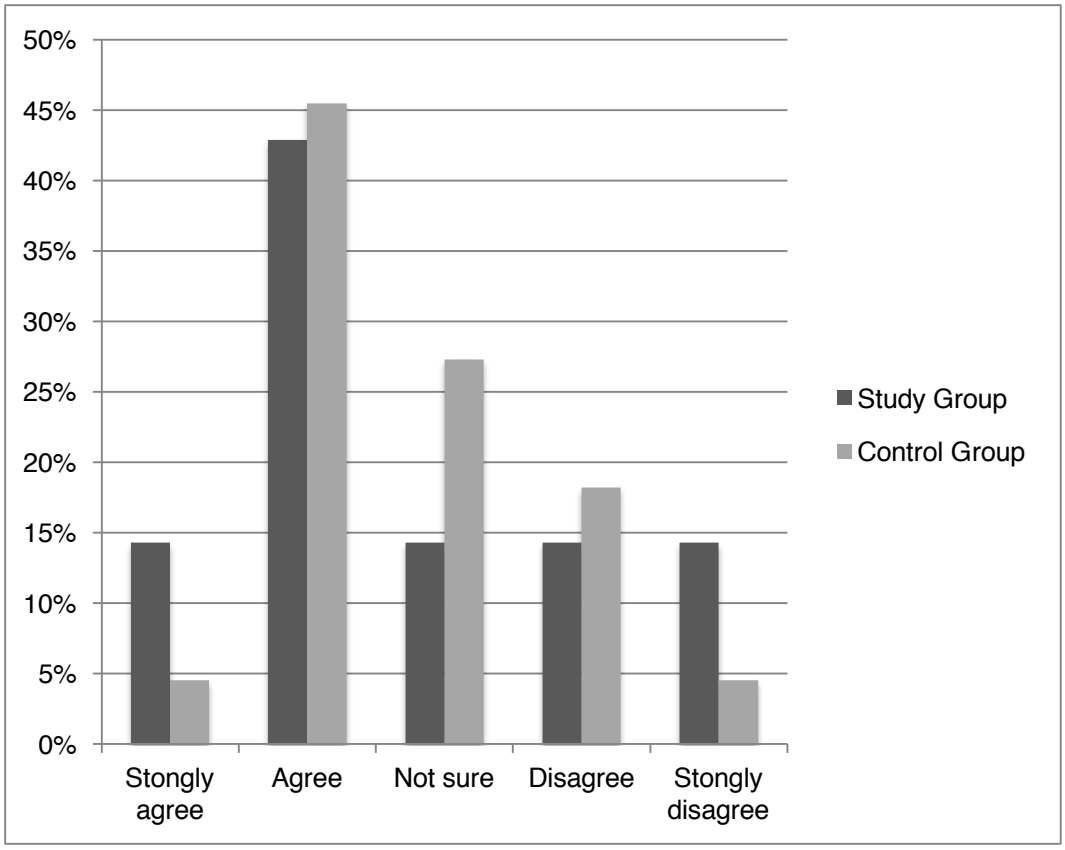


Figure 7.6: Responses to: I judge my own work against precedents to help work out when it is successful

I feel historic buildings are relevant to modern design and architecture

An overwhelming majority of respondents in both groups felt historic buildings were relevant to modern architectural design and 90% of total respondents agreed or strongly agreed with the statement.

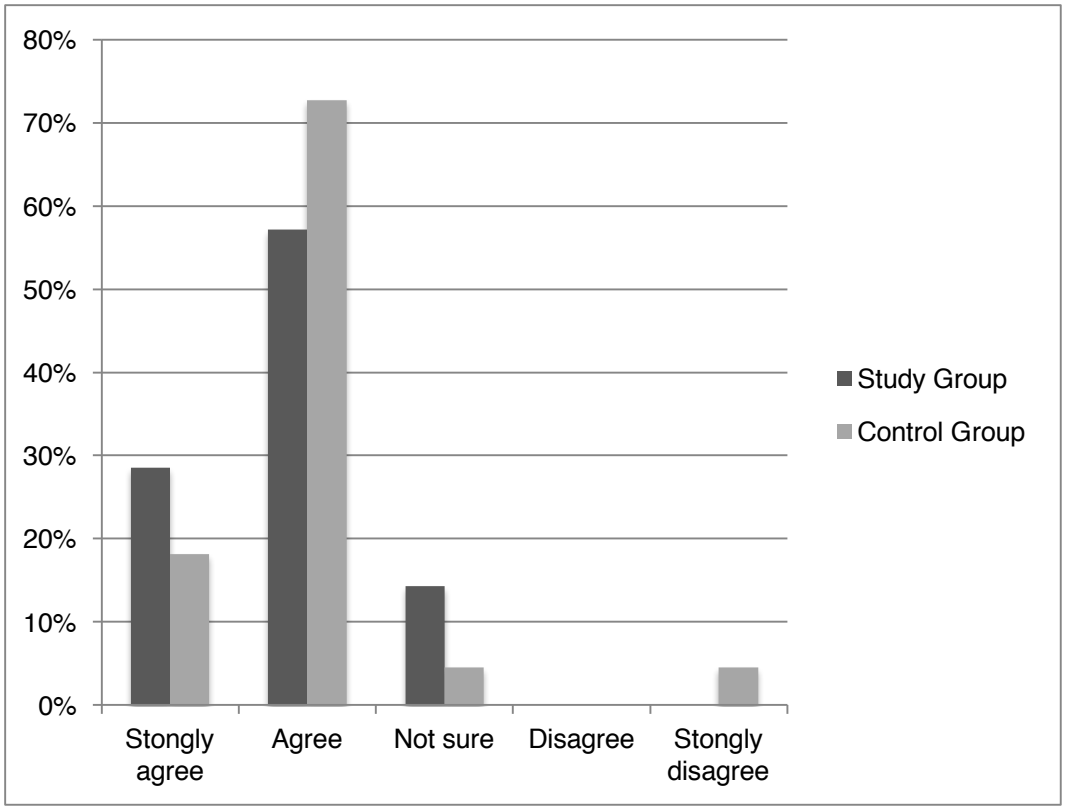


Figure 7.7 Responses to: I feel historic buildings are relevant to modern design and architecture

I feel my work has a strong relationship to the history of architecture

100% of respondents in the study group were unsure of whether their work had a relationship to the history of architecture. On respondent commented:

'I wouldn't say the relationship is strong but underlying.'

Whilst 55% of the control group were also unsure, a significant proportion (36%) disagreed or strongly disagreed with the statement.

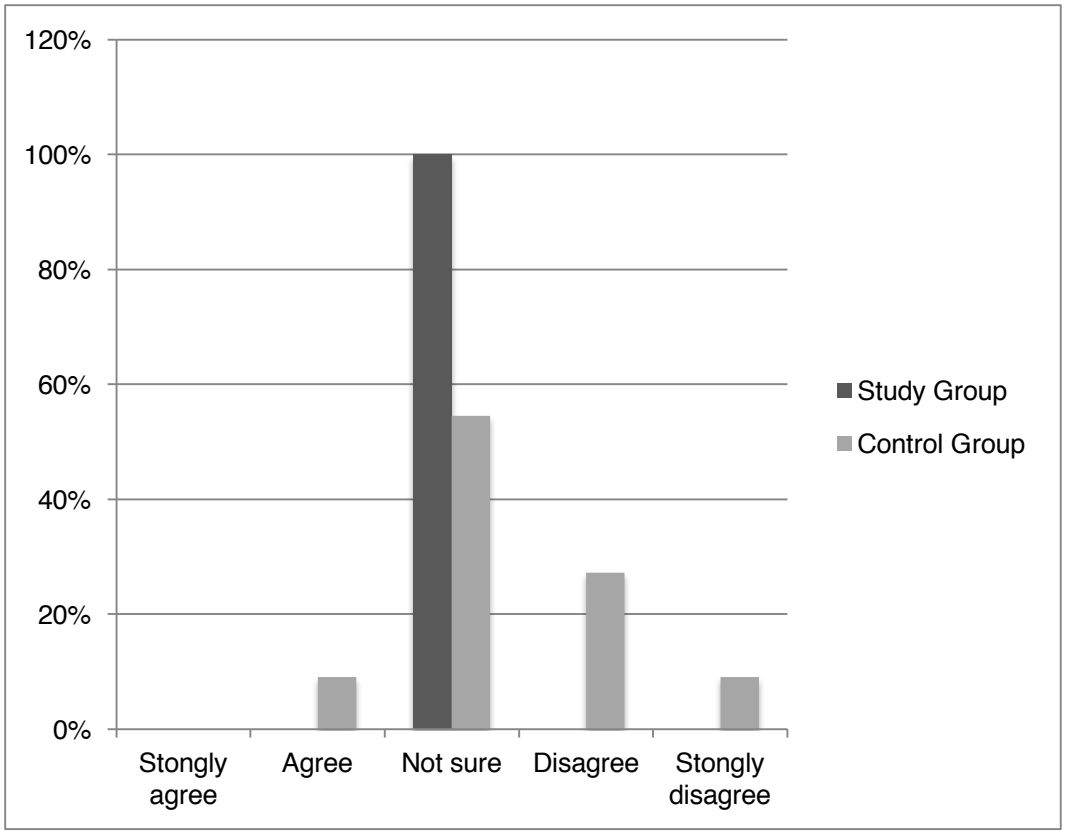


Figure 7.8: Responses to: I feel my work has a strong relationship to the history of architecture

7.6 Limitations of Research Phase 3

Methodological Limitations

Whilst 100% of the study group completed the questionnaire, only approximately 25% of the control group did. Rather than providing a representative sample of the year, the voluntary nature of the questionnaire meant a natural sampling bias likely occurred with only the more motivated students responding. This voluntary element meant only a relatively small number of the student body responded to the questionnaire, reducing the effective sample size.

The questionnaire was limited to the questions posed by the researcher and few respondents provided additional commentary or nuanced responses. The use of personal language, such as '*I feel…',* was intentional to try and assess attitudes towards typology rather than gauge actual design practice. This may have led to the data collected to being neither appropriately nuanced nor statistically significant to draw definitive conclusions.

Interpretative Limitations

The nature of the questionnaire makes statistical analysis challenging. The use of a Likert scale lends itself to visual representation rather than statistical analysis due to the ambiguous and interpretative nature of the categories. Despite this, the graphical displays show few significant differences in the two participant groups making the research phase largely inconclusive.

Research Development

A more appropriate approach for phase three may have been to utilise interviews of the wider student cohort to establish a prevailing trends and attitudes towards typology. Moreover, analysis project work produced by both the study group and control group may have been used to provide a comparative assessment of the efficacy of the framework.

8.0 DISCUSSION AND TYPOLOGICAL LEARNING FRAMEWORK

The discussion of the research is conducted through a triangulation of results in the context of the objectives of the study. It includes an outline and description of a typological learning framework.

8.1 Typology and Heuristics

8.1.1 Typology as an Analytical Tool

The phase 1 research suggests limited effectiveness of a typological pre-design phase, and the control group generally produced higher quality and more novel designs. Typologies were of most use as an analytical tool, to corroborate or modify existing designs. This is supported by the phase 2 findings in which typologies were observed to be of most use to participants once initial design attempts had been made.

In phase 1, presenting participants with written requirements followed by pre-selected typologies yielded an improvement in mean novelty, variety and quality in the second assessment, yet on an individual level this increase was less marked. This was particularly noticeable in the quality scores where individuals, on average retained almost identical levels of quality. Incremental changes in quality were offset by large drops in quality in a number of participants, suggesting exposure to typologies at a later stage may confuse the design space in some students. Nevertheless, individual improvements in all other assessed metrics, lower level of similarity and greater overall levels of quality (compared to the other test groups), suggest introducing typologies as an analytical tool had a greater effect.

This compliments findings by Akin (2002) however is at odds with findings by Eilouti (2009) and Casakin (2004) who suggested that metaphors and cases were best used at pre-design phases. This is perhaps explained by the procedural, problem-solving epistemology that Eilouti (2009) employed which undermined independent heuristic processes. Casakin (2004), on the other hand, presented both metaphors and project briefs simultaneously and so the role of typology in heuristics is unclear.

The case study student presented their work as a process of analysis and synthesis and down played the role of conjecture. Despite this, it is clear from

the report that this process was artificial. At concept design phase, the courtyard types were selected based on the initial conjecture of the plan and thus used as an analytical tool for refinement. Likewise, the development of the elevations followed a *conjecture - analysis* process and there was a clear selection of type based on early conjectures.

'The large industrial space of my studio room draws parallels with warehouses, thus I took inspiration from Speicherstadt, Hamburg to develop the aesthetic of the facade. This resulted in the masonry being expressed as single bricks jutting out in thin columns.'
(Case Study, p.6)

In this case it is clear the *industrial space* preceded the identification of the type. These findings corroborate the work on the Critical Method by Brawne (2003), Bamford (2002) and Wright (2011).

8.1.2 Typology as Definer of the Project Space

In phase 1, the effect of exposing students to visual briefs in the form of plans before written requirements was effective at limiting the novelty and variety of solutions. This suggests students found plan information more helpful at shaping the project space to generate typical spatial arrangements than being presented with imagery or written requirements. These findings are reflected in the work of Casakin (2011) and Eilouti (2009). Moreover, the quality of designs was comparable to the control group in the first exercise, suggesting the appropriate selection of typologies can be as informative as explicitly stated requirements at generating adequate solutions. Exposure to example plans later in the design process (group C1) lead to a reduction in quality suggesting early incorporation may be of value. A number of students cited the value of typologies to narrow their focus and help creativity through the imposition of restraints however only a very small minority felt it limited their creativity ability.

In phase 2, typological exposure was less successful at pre-design. Whilst identification and formation of types was accomplished by some students, all struggled with metaphorical association and application.

8.1.3 Tendency for Imitation

Initial exposure to images lead to more novel solutions in the first phase of the research. There was no increase in variety when compared to the control group reflecting the findings of Sio et al. (2015). Participants tended to extract surface characteristics and not to observe common structural or spatial types, often generating unexpected yet significantly lower quality solutions than the control group. Often, visual characteristics were borrowed from only one or two of the precedent images, indicating a lack of analysis or realisation of common themes.

In phase 2, only a basic formation of typologies and subsequent types in the design process was generally observed. Where types were formed, they were considered elementally and characteristics emulated rather than translated. For example, in the case study, physical characteristics of the picture house were isolated and copied and applied to the house (the curved forms on the exterior). Whilst this maybe suitable when using elemental typologies, this undermines the value of metaphorical and systemic types.

The potential for imitation and the perceived value of originality has led to hostility towards offering students concrete examples as observed by Heylighen et al. (2007). Despite this, research by the same authors, suggests that exposure to precedent leads to higher levels of quality and creativity in student design work (Heylighen and Verstijnen, 2003). The findings of the presented research suggest that metaphorical and systemic types were less readily adopted, and elemental typologies prevailed, this did not appear to constrain the students or cause fixation. The tendency for more basic levels of analysis may be due to the relative design inexperience of the participants.

8.1.4 Adaption of Typological Concepts

In phase 1, when students conducted pre-design based on a set of images a marked improvement in the quality of their designs was observed, compared to the other groups. Both the groups that conducted a pre-design phase without a written brief exhibited greater similarity between assessments when compared to the control group. This implies students were able to adapt existing typological concepts to apply to new situations more readily than existing project spaces could be mapped onto new typologies. Whilst this might imply a degree of design fixation, the improvement in quality suggests this was not disadvantageous. Improvement in quality was particularly

significant when students were exposed to typological images first suggesting significant advantages of individual interpretation in the pre-design phase.

This was developed in phase 2 of the research whereby participants were able to recognise types within their own conjectures, especially at the concept and detail design stages. By independently forming typologies, and identifying them with their own proposals, they were able to refine the project space to add clarity to proposals. This was especially apparent at concept and detail design phases where systemic and elemental typologies were readily identified from the existing designs of participants.

8.2 Developing a Typological Framework

8.2.1 Structure of the Framework

Creating a hierarchy of different typologies was valuable to extract relevant design information required at different stages of the process. In phase 2, the structure of the framework was observed to mimic the structure of the design process and typological ideas were engaged with at the various stages of design. The case study exemplified this approach considering the movie house as a metaphorical typology, the courtyard house as an organisational one and brick warehouses as a detail one. Some basic analysis of related precedents helped generate types and provided some clarity to the design process.

A number of participants exhibited reluctance to modify designs towards the end of the project however others were more willing to do so. This highlighted the rigidity of the framework and suggests a level of flexibility is required in its delivery and tailoring to specific individuals is essential. Moreover, it suggested some participants considered the project space as a problem to be solved. In part this may be due to the nature of the brief and the assessment criteria focussed on goal orientated outcomes rather than processes.

The case study exhibited a clear development from a model typology (the picture house) to a spatial organisational typology (the courtyard house) to elemental typologies (rhythmic pilaster to flush bricks and projecting openings). This structure provided clarity to the design process and guided the use of precedents at different stages.

The capacity of structured frameworks to provide guidance for novice designers corroborates work by Curry (2014) however limitations of the framework however must be noted. Architectural design cannot be considered a purely linear process, and as the project progressed, it was clear students were at different stages in the design. This was reflected in one student's comments:

'You have an extremely organised timeline but everyone progresses differently. Perhaps some more flexibility!'

8.2.2 Independent Typology Formation

In phase 2, participants diagrammed plans of participants' own schemes in parallel with precedents allowing the independent formation of types and the identification of relevant precedents. By contrast, in phase 1, plan typologies were imposed by the instructor and participants were unable to map this information to existing conjectures. Self-generated typologies appeared to yield a greater understanding of precedent and design integration.

In the case study, a tendency to consider precedents individually rather than examples of typical occurrences was exhibited. This was also observed in analysis of the output of the phase 2 study group. This acted as a barrier to typological framing and was especially true in the earlier design stages where further reduction of type may have provided more generally applicable axioms. In the case study example, the analysis of the picture house may have included cultural associations, and considerations of activities it facilitates as well as formal characteristics drawn from a wider range of precedents. Similarly, organisational types could have been developed through a greater number of precedents to develop more general spatial diagrams typical of the courtyard.

8.2.3 Pedagogic Implementation

The importance of the changing roles of the tutor was highlighted in phase 2. There was observed a correlation between the required level of facilitation and the depth of understanding of the participants. At the early stages of design, when metaphorical typologies were introduced, the focus was on independent typology formation and the tutor took a supportive role to encourage understanding. At this stage personal discovery and development was deemed most important and tutor tasks involved facilitation, prompting and overseeing

of active participation exercises. Whilst this appeared to encourage greater engagement, levels of dialogue and understanding, uptake and use of metaphorical typologies was generally poor. By contrast, at the detail design stage, more basic analytical tasks such as visual recognition and emulation, meant the tutor was able to take a more instructional role. Application of elemental types was much higher, probably due to the clarity of instruction and the basic skills required for application, however it was observed there was a lack of typological abstraction.

Active workshops where participants worked in groups or individually, encouraged interaction and engagement with the session which helped identify connections between individual work and the workshop. Despite this, participants generally preferred a more direct means of delivery as this was associated with learning and knowledge acquisition.

Participants highlighted various practical issues, essential for the satisfactory delivery of the workshops that without consideration may have affected the capacity of individual learners. These included the quality and quantity of resources, their presentation, physical access to resources and adapting sessions to meet different learning styles.

'I remember the presentations, seeing the different images of precedents. I'm definitely a visual learner.'

8.3 The Value of Typology

8.3.1 Creative Boundaries

Creativity remains a key tenet of perceived success in the studio as noted by McClean (2009). The third phase of the research suggests that precedents were not deemed to limit creativity in either the phase 2 study group or the control group. Whilst a number of the control group agreed that precedent might pose some limitation on design, the entire study group felt that precedents did not impinge on their creativity.

By contrast, phase 1 of the research suggests that exposure to typologically organised precedents limited the variety of solutions. Novelty was increased with exposure to pictorial examples of type whilst diminished with diagrammatic (plan based) examples. This may suggest the ability of typologically organised

precedents to pre-structure a project space and thus limit the number of potential avenues. A number of students highlighted the necessity for restrictions to enhance creativity.

The discrepancy between perceived creativity and actual solution variety may be caused by the pre-selection and imposition of precedents in phase 1 compared with the independently formed typologies in phase 2. Moreover, it is important to note that despite having typologies imposed, participants in phase 1 still felt that their creativity was enhanced by visual stimulus.

8.3.2 Interpreting Precedent

The difference observed in phase 3 of the research in question four (when I pick precedents for my work I choose them because they have a similar function to my brief) supports the effectiveness of the framework's capacity to allow students to extract a wider array of design information from precedents beyond functional similarities. This suggests a capacity to analyse precedent and extract relevant design information. Nevertheless, the test group was split in responses and 63% of respondents still chose to agree with the statement. This could be explained through the varying abilities within the group, while more capable students were able to analyse and extract relevant precedent characteristics, weaker student may have reverted to establishing more apparent connections between precedents and their own work.

8.3.3 Perceived Role of Precedent

The similarity observed in the responses to the other statements asked in Phase 3, suggests respondents already had an awareness and an appreciation for the role of existing cases in design, used precedent as a basis for conjecture and were already beginning to analyse their work in relation to precedent. The use of precedents however, appears to be limited to functional similarities suggesting a lack of analysis or reduction to typologies.

One respondent revealed that their reluctance to design using intuition was due to perceived inexperience or lack of confidence. This could suggest an attitude that intuition is superior to other methods, and the use of precedent and type could be considered inferior.

It may be postulated that a lack of architectural experience and knowledge of buildings may restrict formation of types (observed in the case study). Without a large internal library of precedents, formation of types is inherently challenging and the student fell back on a limited number of precedents to provide the general axioms that defined the type. Accordingly, the types generated were little more than reduced precedents.

8.4 The Typological Framework

8.4.1 A Taxonomy of Operational Processes

The researcher observed a number of operational processes that took place during the analytical phase of the Critical Method. A taxonomy of tasks was identified that describe the heuristic processes as:

- Initial **conjecture**
- **Identification** of typology and **formation** of types
- **Association** with proposals and **application** of types
- **Verification** of proposals (corroboration, modification, rejection)

The nature of each of these operations changed at each stage of the design process and these are outlined and an ideal process set is outlined in table 8.1.

Design Stage	Relevant typology	Conjectures	Identification and Formation	Association and Application	Verification	Role of the Educator
Frame definition	Metaphors	Primary generators Programme Context	Cultural Symbolic Experiential	Generative Abstraction Translation	Corroboration Modification Rejection	Supportive Catalytic
Concept Design	Systems	Diagrams Strategies Volumes Forms	Formal Spatial Structural	Rationalisation Clarification Adaption	Corroboration Modification Rejection	Catalytic Inform
Detail Design	Elements	Elements Details	Elements Parts Conditions Moments	Emulation Clarification Replication Consistency	Corroboration Modification Rejection	Inform Prescribe

Table 8.1: Taxonomy of Typological Operations

At the frame definition stage, identification of metaphorical typologies and the formation of symbolic, cultural and experiential types was required to begin framing the project space. No participants of the phase 2 research were

observed to do this to a level that fully shaped their design process. At this stage, most participants found it challenging both to translate abstract primary generators to typologies and to form metaphorical typologies. The limited number of precedents offered may well have been a contributing factor as it did not offer enough scope for formation. Moreover, the presentation of precedents in plan drawing and photographs may have led to a focus on visual characteristics rather than uncovering cultural and social ones. A low level of analysis at this stage in the case study project prevented the student from extracting more general design information that may have helped frame the project space and aid application.

At this early stage, the process may have been more successful without the presentation of precedents, perhaps asking participants to define a type of space that might embody their primary generators, either through writing, drawing or other mediums. This may encourage independent typology formation.

At concept design stage, the identification and formation of types was more successful aided by the practical activity of diagramming precedents. Moreover, association with schemes was strong however application of types remained poor. Whilst the diagramming process allowed for inherent rationalisation, this appeared to stem from the act of creating diagrams rather than through the application of type. One reason for this may have been fixation of novice designers and unwillingness to make large scale changes to their schemes. The participants who most successfully employed systemic types were willing to make greater changes to their schemes.

Elemental types proved to be the most readily accessible typology and participants in phase 2 of the research were easily able to identify, form and associate relevant typologies. As such elemental types could be readily understood as surface characteristics, little analysis was needed which may indicate why they were simple to apply. Processes of application were emulative rather than translational and which, the research suggests, were more easily to apply.

The hierarchy of typology maybe valuable in the teaching of students of mixed abilities whereby those more capable are able to undergo a greater depth of analysis to generate independent typologies whilst weaker students can revert to the identification of surface characteristics. This distinction is important in

groups of mixed ability and may suggest how the educator may adapt methods to suit individuals.

8.4.2 The Framework

Figure 8.1 represents the typological framework considered against the progression of a typical design project. The x axis represents the stage of the project which radiates from a notional conception point. The overall coloured area represents the gradually expanding project space whilst the blue area represents a metaphorical typology which shapes the whole problem frame. The orange areas are systemic typologies and the red areas are elemental typologies (of which there are the most however shape the least amount of the project space). The typological areas overlap to represent the continuing influence of typologies throughout the process. The gradually increasing definition of the project is plotted as continuous line which loops back at the end of each stage to represent the heuristic cycles that the designer goes through. In reality, projects and typologies may be introduced at any stage and the model allows the possibility to loop back to any previous stage.

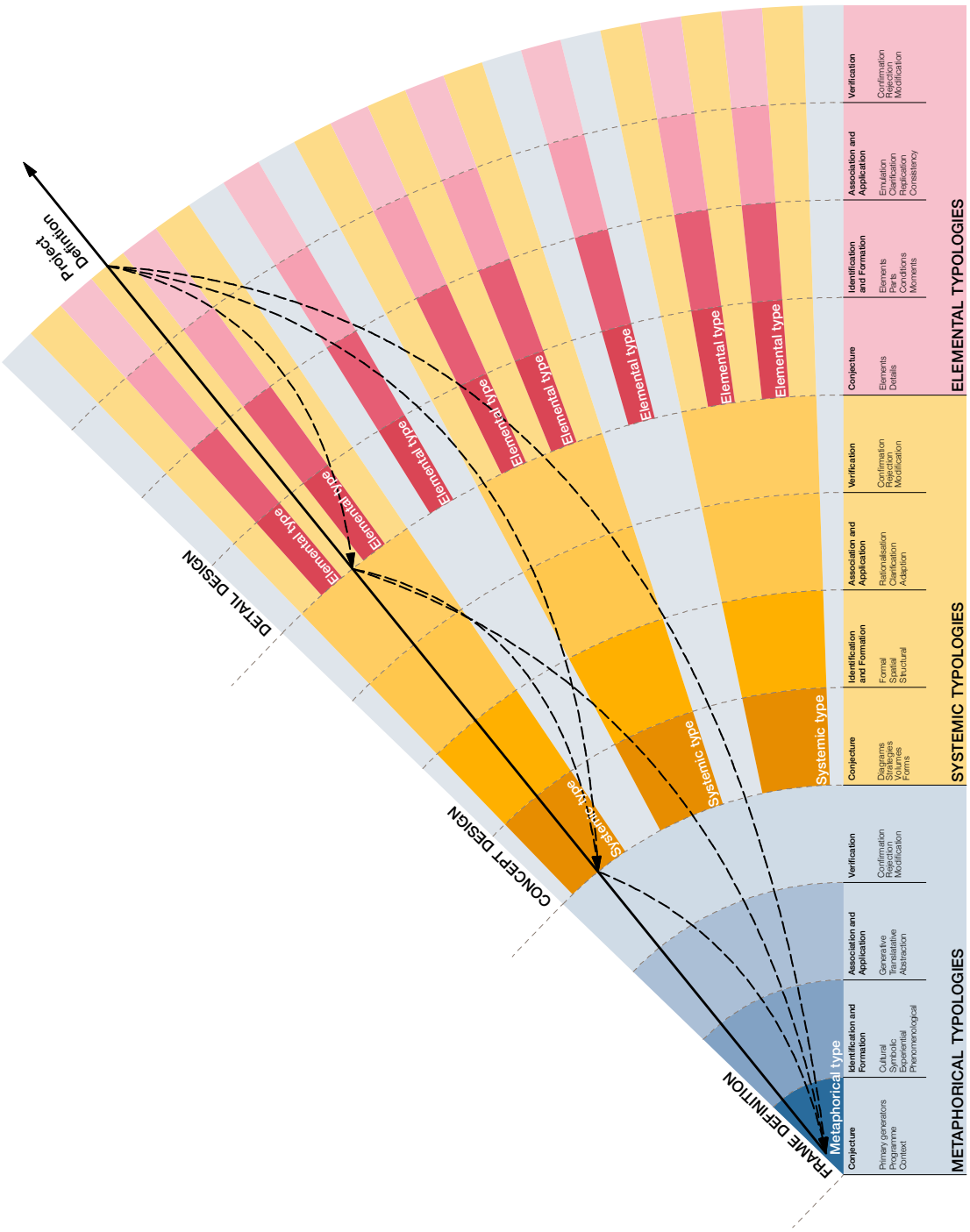


Figure 8.1: The Typological Framework

Each aspect of the framework is considered in greater depth below and recommendations for tutors at each stage discussed.

8.4.3 Frame Definition

Intended Outcomes

At this stage the primary intended outcome is to define general axioms that may loosely structure the project space. This typically involves a translation of abstract primary generators to model typologies with an emphasis on making the project 'architectural' as possible. The typology to be considered at this stage is the metaphorical typology. Interpreting precedent through metaphorical typology may allow the extractions of cultural, phenomenological and symbolic design information and their associated structures and forms.

Conjecture

The analytical processes can only take place after initial conjectures have been made. At this stages conjectures are based on primary generators, programmatic issues and contextual factors.

Identification and Formation

Identification of this typology requires the greatest level of analysis and learner understanding. Borrowing from Quatremère de Quincy, this typology must be considered for its metaphorical significance rather than its physical attributes.

At this early stage it is important to establish and make explicit primary generators. Whilst abstract or deterministic generators may be inevitable with novice designers, there is a focus on translation to typology. Independent formation of type is thus imperative, to engender greater learning understanding.

Non-visual modes of identification may also be employed (such as narrative text) to develop metaphorical entities. This may encourage richness and depth

of analysis and provide a means to connect abstract primary generators with typological descriptions.

Association and Application

Application takes the form of generating ideas, translating concepts and abstracting conditions. At this stage, specific precedents may challenge the identification of the type and learners may be tempted to resort to clearly identifiable visual characteristics and elemental application. One approach may be to focus on individual interpretation and encouraging learners to draw from personal experience and knowledge. Novice designers maybe limited in the range of architectural experiences they can draw from and thus the role of the instructor is important to support and catalyse ideas.

Alternatively, pre-defined types may be presented by the instructor, and students may choose to adopt these or develop their own. In this case student understanding is likely to be compromised.

Verification

Verification at this stage takes the form of corroboration, rejection or modification of primary generators, which frame the project space.

The Role of the Educator

The role of the educator is vitally important at this stage in the design process due to the depth of analysis required and the challenge posed to novice designers. In the first instance, it must be made clear what purpose of the session is and the notion of typologies introduced.

The tutor must take a supportive and catalytic role to facilitate activities which themselves must be clearly defined to provide structure. This is particularly important with novice designers where independent working may pose a challenge to weaker students.

Group work was successful at this stage as types are more general and non-specific however this requires guidance and facilitation by the educator to ensure the formation of model types.

Challenges

The research suggests a number of challenges for novice designers at frame definition stage. Initially, many found it hard to translate between abstract primary generators and concrete types and some direct instruction was required.

In most cases operational processes of type formation and abstract association were not sufficient to define the project frame and there was a tendency to not to form types but rely on precedents applied elementally. Omitting precedent information and encouraging narrative accounts of type may help alleviate this.

Many participants did not fully understand the purpose of the session, considering it a means to define the determining characteristics of the brief rather than translate theses to types.

The formation of complex types requires a wealth of architectural experience on which to draw on, a clear challenge with novice designers. The presentation of specific cultural types by the instructor may prevent this however care must be taken that it does not undermine independent type formation. Without either an array of experience or in depth analysis of various types, understanding cultural significance of types was challenging.

The group work and independent formation of types alienated some weaker members of the group. Again, responsibility falls on the tutor to ensure such scenarios do not occur.

8.4.4 Concept Design

Intended Outcomes

At this stage, the intended outcomes are to develop strategies (structural, spatial, etc) that may inform the physical manifestation of the architecture. Typologies were considered as systems and types provided organisational strategies for further design. Utilising systems typologies, may be used to extract spatial, structural and organisational patterns embedded in precedent.

Conjecture

Conjectures at this stage in the design process take the form of strategic ideas, volumes and forms (amongst others).

Identification and Formation

At this stage, the direct analysis of precedents was found to be a successful way of revealing strategies. Active analysis through diagramming provided a means of revealing organisational strategies and grouping similar strategies into types. Typologies are identified in a strategic manner and formal, structural and spatial types are examples of categories that might be formed.

It is suggested that students might each analyse and reduce a number of unique precedents to strategic information. Then working as a group, these can be categorised into types. In order to reveal types, a significant number of precedents must be considered for their organisational strategies. Working as a group can provide an expedient way of creating numerous diagrams of various precedents. Forming types as a group can also provide a means to generate and share multiple types.

Association and Application

It is important at this stage that a similar level of analysis is undertaken to associate individual projects to precedent examples. Moreover, the act of diagramming often highlighted flaws and revealed opportunities in proposals. Where new or hybrid types are revealed, the tutor must facilitate this development. Application was generally observed to rationalise schemes, clarify ideas or to adapt existing plans.

Verification

Verification takes the place mostly through modification of proposals however diagramming and comparison can expose flaws which may lead to rejection or conversely corroborate successes.

The Role of the Educator

The educator's role is to be both catalytic and informative. Examples of precedent analysis was helpful in the initial stages of the workshop. During the

categorisation stage, it is important for the tutor to facilitate the formation of types.

Practical considerations for the educator at this stage include the provision of significant number of precedents in adequate detail. Each student must also have access to the varying precedents. This means a significant amount of preparation must be made by the tutor.

Challenges

There exists an inherent bias in the presentation of precedents, especially if these are preselected by the instructor. One way around this maybe the asking the participants to provide a variety of precedent information or the construction of a database that maybe added to by students and the instructor from which precedents are drawn.

Some students exhibited a tendency to make diagrams too specific, simply emulating plan drawings rather than revealing spatial or circulatory strategies. Again the role of the instructor is imperative to ensure an adequate level of abstraction.

8.4.5 Detail Design

Intended Outcomes

At the detail design stage the intended outcome is the formation of the artefact. Typologies are considered as elements, addressing specific parts of the artefact. The focus is on providing coherence to parts and solving specific issues. Embedded design information is at a functional, visual, or technological level and its extraction requires only basic analysis.

Conjectures

At this stage, conjectures take the form of elements and details. These are individual moments in any proposal that can be reduced and considered in isolation from the whole. Examples may be openings, ornamentation or encrustation.

Identification and Formation

At this stage the most basic level of analysis is applied. This takes the form of the identification of common visual elements and strategies to address various issues. Types are formed around common parts for example, the expression of openings or the manifestation of roofs.

Association and Application

Application of types is emulative, replicative and clarifying often used to provide visual constancy to proposals whereby types closely map to physical solutions. The low level of abstraction creates little separation between type and specific instance ensuring simple application.

At the level of detail design, many of the issues may well be of a problem-solving nature and there may exist only a finite number of solution strategies. The emphasis is on practical application rather than independent type formation and participants responded well to pre-defined solution types.

Verification

Verification again takes the form of rejection, modification or corroboration of proposals. Generally, participants in phase 2 were observed to modify proposals to provide clarity to existing ideas. In a number of cases, ideas were rejected to enable visual consistency.

The Role of the Educator

At this stage, students favoured a didactic approach. Due to the basic and finite reductive analysis, pre-defined types were presented to and selected by, students. The role of the educator is one of an informer.

This approach requires a significant amount of preparation by the educator, searching, selecting and organising types. This could be student led but relies on the educator providing typological categories for consideration. Such an approach may engender a greater level of learner independence and understanding of the problems faced at the detail design stage.

Challenges

The method incorporates a significant amount of inherent bias both in the selection of precedents and the selection of typologies. One way to mitigate this may be to encourage students to produce these in advance, perhaps preparing their own precedents or typological categories.

The similarity between the type and the specific instance allows significant emulation and replication of precedents. Whilst this may sometimes provide appropriate solutions, without understanding of the intentions of the precedent, possibly allows for misuse and typological formation must be emphasised.

8.5 Limitations of the Research

An overview of the limitations of all research phases are discussed here whilst the limitations of each phase are discussed in chapters 5, 6 and 7.

The research was conducted within a single school of architecture, with a limited sample size of participants, all with similar backgrounds and architectural experience. Whilst both the school and the participants may be considered typical to UK architectural education, the representativeness of the findings is limited and care must be taken in the extrapolation of the results.

Phase 1 of the research (the quasi experimental research) was conducted as an outside of the design studio and projects. Decontextualising the experiment from the natural conditions of the design studio meant the work was limited in scope and representativeness. The contrived nature of the study avoided the complexity of the design process and was not a true reflection of the Critical Method in practice. Nevertheless, it allowed isolation of the experimental variables, the establishment of a control group and a tailoring of the work to suit the experiment.

All phases were also limited by the external brief. In the early stages and the formation of the project frame, greater integration between brief and typology may have helped. Imposing a typological framework left some participants at odds between the requirements of the brief and the seemingly irrelevant formation of types. This was evidenced in the design reports where much of this work was ignored or omitted and the tendency for some participants in phase 1 to focus on practical requirements of the brief.

The nature of studio environment may also provide limitations to the success of the framework. Stevens (1995) has noted the tendency of the studio to favour and develop a certain 'type' of student. The very context of the experiment could act as a barrier to some students' receptiveness to the framework.

The success of the framework is limited to the individual motivation of the student and educator. Without willing adoption of the framework by the student and willingness to implement by the educator, the framework is irrelevant.

The framework assumes a structured design process thus its application is limited to adherence to this structure. Nevertheless, the framework does not rely on ordered implementation and sections of the framework could implemented in any order. For example, one may begin with the definition of elements of the scheme and draw from elemental typologies following organisation utilising a systemic type.

When working with novice designers, the framework requires facilitation by an educator who themselves has some experience with its implementation. The research suggests novice designers require guidance and structure at all stages of the process.

The framework has been tested on a very specific type of student brief that is goal driven, structured and culminates in the formation of a building. The framework may not be applicable to more abstract or explorative student projects.

9.0 CONCLUSIONS AND RECOMMENDATIONS

9.1 Introduction

The research aimed to understand how precedents maybe interpreted typologically to enhance understanding and analysis by novice designers. A conceptual synthesis was made between theories of typology and design methods to provide a practical framework for the application of typology in design studio teaching. The framework was constructed around a stage-based model of design underpinned by the Critical Method as a description of individual design cycles.

The thesis began with a literature review which outlined the theoretical basis of the research. Chapter 2 provided a broad overview of the literature in design methods and critically discussed them in the context of the design studio. Chapter 3 considered the historical role of typology and discussed its various interpretations. It also provided a synthesis between theories of type and a stage-based model of the design process.

The thesis then addressed the three primary objectives directly through a series of exploratory studies and the methodological approach was outlined in chapter 4. Each objective was addressed by a different research phase, as described below.

Objective 1

The first objective was to examine the effect of the introduction of typologies on heuristic processes and the conjecture and analysis phases of the Critical Method. This was addressed by phase 1 of the research, described in chapter 5, which presents the methodology and results of an experimental study into the adoption of typologies into the design process of novice designers.

Objective 2

Chapter 6 presents the methodology and results of phase 2 of the research; a participant observational study of eight novice designers in the design studio setting. The research set out to develop a strategic pedagogic model for the introduction of typology into the design process. It was developed through

practical workshops and data was collected through observations, student feedback, structured interviews and case studies.

Objective 3

The value of the established pedagogic model in the studio environment was assessed in chapters 6 and 7. Chapter 6 presents direct student feedback and results and chapter 7 describes the results of a comparative study into the effectiveness of the typological framework.

Chapter 8 draws together the results of the three research phases and discusses them in the context of the original aim and objectives of the research.

9.2 Conclusions

It is clear from the research that typology, as a means to extracting design knowledge embedded in architectural precedent is challenging to many novice designers. Respondents to questionnaires appear to acknowledge the role of built examples but appear unclear on how it influences the design process. When questioned, most appear to select precedent based on shared function with the brief suggesting a non-analytical approach, supported by evidence presented in design reports.

Assessment of ideation metrics (in phase 1) has previously taken place mostly in the fields of engineering and industrial design where solutions can be assessed against desire outcomes. In these contexts, novelty and variety are valued as providing fresh insights into the problem solving process. The nature of architectural design is such that concrete outcomes are not always obvious and designers are called upon to construct their own design situations to frame the project. Conducting a pre-design phase, with the absence of written requirements, proved effective at limiting the scope of the project space and lack of novelty or variation could be considered advantageous. This may be of particular value in CM where the symbiotic relationship of conjecture and analysis requires the formation of clearly defined analytical structures.

In the context of CM, the value of novelty and group variation are not explicit. Whilst the generation of multiple and various ideas is advantageous to explore the project space, without developing critical frameworks, the ability to analyse

their success is compromised. Exposure to preselected types appeared to enable rudimentary critical frameworks to be constructed however this was severely limited by a lack of analysis.

The research suggests that typological integration is most valuable at the analysis phase of CM. Attempts to modify primary generators and translate them to typological project frames were generally observed to be unsuccessful. Following initial conjectures, typological analysis offered a valuable means of interpreting proposals.

There appears value at attempting to encourage typological formation and the association with type throughout the design process. Typological organised precedents are not perceived by students as a barrier to creativity yet appear to limit the novelty and variety of designs. The results of phase 1 showed introducing typological stimulus after initial conjectures yielded higher quality solutions however most participants exhibited only basic application and analytical skills. This puts forward the case for independent type formation, to allow students to shape their own project space typologically. In phase 2, it was observed that independent learner generation of typologies, for example the creation of spatial plan types, encouraged understanding and higher level of analytical thought.

The typological framework suggests a hierarchy of typologies can be mapped to the design process. In the project definition stage, metaphorical typologies requiring greater analysis and abstraction to reveal typical conditions were used to help shape project frames. At concept and early design stages, systemic typologies involving formal and spatial analysis provided general organisational strategies. At the detail design stage, typologies were understood in an elemental manner, used to solve specific design problems requiring low-level skills of analysis and adaption.

Novice designers often interpreted precedent at a basic level choosing precedents that followed function and emulating easily replicable physical attributes. They exhibited a tendency to extract specific knowledge from isolated instances rather than using a wide range of examples to formulate typologies and extract more general axioms. This may act as a barrier to design knowledge extraction, both in the limited pool from which precedents are drawn and the depth of analysis undertaken. This suggests a typological approach

which avoids specific examples and focuses on typical conditions is a more effective means of extracting design knowledge for new proposals.

9.3 Recommendations

The research suggests that when working with novice designers, independence within a wider structured framework is of value to understanding and personal development. The presented framework can act as a means for individual interpretation of precedent through typology and it is recommended that educators utilise the pedagogic methodology outlined. Whilst the supportive role of the tutor is a valued one, there is also a clear desire for more structured and traditional learning that takes place in parallel and with relevance to studio design projects.

It is recommended that the consideration of a wide range of types and typological formation should be encouraged. Isolating particular buildings or designers may be unhelpful when attempting to extract more general design knowledge and a typological understanding of precedent helps to engender a wider range of design information extraction.

The research made clear the shortcomings of post-positivist research techniques when applied to the subjective and complex realm of the design studio. A constructivist epistemology that adopts ethnographic methods provided data of greater validity and value to the research objectives and should be considered by researchers when engaging in similar studies.

9.4 Contribution to Knowledge

The research contributes to the wider field of knowledge by introducing a structured learning framework for use by both teachers and students of architecture. Theories of typology have often remained interpretative and their connection to the design process not always apparent. By synthesising typological theories with a structured description of design, the framework provides an outline for further typological research. The research draws from and compliments similar frameworks for precedent integration set out by Eilouti (2009) and Tunçer (2009).

The research also contributes to the wider historical discourse surrounding typology. Building on the hierarchy introduced by Argan (1963) and the categorisations of typologies advocated by Vidler (1977), Moneo (1978), Johnson (1994), Güney (2007) and Carl (2011), the research creates a systematic structure for historical typological interpretation.

The research proposes a structured framework that guides novice designers through the design process. Curry (2014) has proposed the use of theories of design methodology may provide guidance and the proposed framework reflects and contributes to this work. This feeds into a wider understanding of the operational processes in the design studio building on work by McClean (2009) and Schön (1985).

Further contribution may be understood in the field of design methods. The research places the Critical Method as described by Wright (2011), Brawne (2003) and Darke (1979) amongst others in the context of a stage-based approach to design, offering structure to individual and heuristic processes and providing a practical framework.

9.5 Evaluating the Research

The strengths of the research lie in the conceptual synthesis of theories of typology and the design process and the formulation of a conceptual framework. Bridging the gap between theoretical studies and the design studio, the research offers a practical methodology for educators of novice architects to adopt. This practical approach is distinct from the theoretical studies that dominate the discourse.

Methodologically, the research utilises a mixed mode approach generating data from case-studies, quasi experimental studies, participant observation, structured interviews and questionnaires. This approach provides a triangulation of data uncommon in the fields of design studies or typology. Accordingly, the depth of each study could be enhanced to provide a more reliable picture at each phase.

Due to the explorative nature of the research, it is not possible to construct an accurate picture of the strength of the framework, its validity,

representativeness and application. Its limited scope and non-representative sample size, makes such extrapolations an impossibility.

The research relies on a systematic and structured teaching delivery and a mechanistic interpretation of the design process. Whilst the literature suggests design is far more complex, the research argues that as a pedagogic strategy a loosely structured approach may be beneficial to give clarity to novice designers.

There exists a risk of misinterpretation of the research and it should not be understood as a comprehensive method. The data collected to support the framework is not representative but record an isolated incidence of its application.

9.6 Recommendations for Further Research

The research could be developed through continued testing and development of the framework in wider variety of contexts. This may mean in different schools, and with students at different stages in their architectural education. Examining the effect of implementation on more experienced students, with a greater working knowledge of precedents would be of particular value. Moreover, testing on the framework on a variety of architectural briefs, set at different schools of architecture would be of value.

Further study needs to be undertaken to help students develop a deeper understanding of typology at the pre-design phase. This could be through self-selection or formation of typologies related to a broad and non-specific written brief. It is hypothesised that lack of understanding was the primary barrier in the successful integration of typology and that its effectiveness as an ideation tool.

The structure of the framework shares similarities with the RIBA Plan of Work (Royal Institute of British Architects, 2013) and further research could be done to provide a structured typological overlay to the Plan.

REFERENCES

ACHTEN, H., OXMAN, R. & BAX, T. Typological knowledge acquisition through a schema of generic representations. Artificial Intelligence in Design'98, 1998. Springer, 191-207.

AKIN, Ö. 2002. Case-based instruction strategies in architecture. *Design Studies,* 23**,** 407-431.

ALBERTI, L. B. 1775. *The Architecture of Leon Battista Alberti in Ten Books,* London.

ALBERTI, L. B. 1966. De re aedificatoria (1486). *Latin text and Italian trans. by G. Orlandi. Milan: publisher*.

ALBERTI, L. B. 1988. *On the Art of Building in Ten Books,* Cambridge, MA, The MIT Press.

ALEXANDER, C. 1979. *The timeless way of building*, New York: Oxford University Press.

ALEXANDER, C., ISHIKAWA, S. & SILVERSTEIN, M. 1977. *A pattern language: towns, buildings, construction*, Oxford University Press.

ALLEN, I. E. & SEAMAN, C. A. 2007. Likert scales and data analyses. *Quality progress,* 40**,** 64.

ANAY, H. 2006a. Creative use of Architectural Precedents in Design Education: A Framework for a Computational Model. *eCAADe, Design Theory and Computing.* Volos, Greece: University of Thessaly.

ANAY, H. 2006b. On the Relevance of Karl Popper's Evolutionary Epistemology for Architectural Education. *1st International CIB Endorsed METU Postgraduate Conference.* Ankara.

ANAY, H. 2007. Outline of a theory studying past architectural works. *Inernational Association of Design Research.* Hong Kong Polytechnic University.

ANDERSON, J. Undercurrent: Swimming away from the design studio. Proceedings of the first international conference of the Association of Architectural Educators-‐AAE:(un) common currency. Nottingham Trent University, UK. Available: http://architecturaleducators/. wordpress. com/conference-‐2013/conference-‐2013-‐papers/(accessed: 21 July 2014), 2013.

ANDERSON, S. 1982. Types and conventions in time: Toward a history for the duration and change of artifacts. *Perspecta***,** 109-117.

ANSTEY, T., GRILLNER, K. & HUGHES, R. 2007. *Architecture and authorship,* London, Black Dog Publishing.

ARCHER, L. B. 1964. *Systematic method for designers*, Council of Industrial Design.

ARGAN, G. C. 1963. On the Typology of Architecture. *Architectural Design*.

ASIMOW, M. 1962. *Introduction to design,* Englewood Cliffs, NJ, Prentice-Hall

BAILEY, K. D. 1994. *Methods of Social Research,* London, Simon and Schuster.

BAMFORD, G. Design, Science and Conceptual Analysis. *In:* PLUME, J., ed. Joint ANZAScA / ADTRA conference, 1991 Sydney. University NSW.

BAMFORD, G. 2002. From analysis/synthesis to conjecture/analysis: a review of Karl Popper's influence on design methodology in architecture. *Design Studies,* 23**,** 245-261.

BAZJANAC, V. 1974. Architectural design theory: Models of the design process. *Basic questions of design theory,* 3**,** 20.

BERTALANFFY, L. V. 1950. An Outline of General System Theory. *The British Journal for the Philosophy of Science,* 1**,** 134-165.

BÖTTICHER, K. G. W. 1852. *Die tektonik der Hellenen*, Riegel.

BRACHT, G. H. & GLASS, G. V. 1968. The external validity of experiments. *American educational research journal***,** 437-474.

BRAHAM, W. W. 2000. After Typology: The Suffering of Diagrams. *Architectural Design, "Contemporary Processes in Architecture",* 70**,** 9-11.

BRAWNE, M. 1992. *From idea to building: issues in architecture,* Oxford, Butterworth-Heinemann.

BRAWNE, M. 2003. *Architectural Thought: The Design Process and the Expectant Eye,* Oxford, Architectural Press.

BRITISH EDUCATIONAL RESEARCH ASSOCIATION. 2011. *Ethical Guidelines for Educational Research* [Online]. Available: https://www.bera.ac.uk/wp-content/uploads/2014/02/BERA-Ethical-Guidelines-2011.pdf [Accessed 22 May 2016 2016].

BUCHANAN, R. 1992. Wicked Problems in Design Thinking. *Design Issues,* 8**,** 5-21.

CAMPBELL, D. T. & STANLEY, J. C. 1963. *Experimental and quasi-experimental designs for research on teaching*, American Educational Research Association.

CARL, P. 2011. Type, Field, Culture, Praxis. *Architectural Design,* 81**,** 38-45.

CASAKIN, H. 2004. Metaphors in the Design Studio: Implications for Education. *International Engineering and Product Design Education Conference.* Delft, The Netherlands.

CASAKIN, H. 2011. Metaphorical reasoning and design expertise. *Journal of Learning Design,* 4**,** 29-38.

CASAKIN, H. & DAI, W. 2002. Visual typology in design: A computational view. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing,* 16**,** 3-21.

CHURCHMAN, C. W. 1967. Guest editorial: Wicked problems. JSTOR.

CLARK, R. H. & PAUSE, M. 2012. *Precedents in architecture: analytic diagrams, formative ideas, and partis,* London, John Wiley & Sons.

COHEN, L., MANION, L. & MORRISON, K. 2000. Research Methods in Education [5 th edn] London: Routledge Falmer. *Teaching in Higher Education,* 41.

COLQUHOUN, A. 1969. Typology and Design Method. *Perspecta,* 12**,** 71-74.

CORBUSIER, L. 1987. *The city of to-morrow and its planning*, Courier Corporation.

COYNE, R. 2005. Wicked problems revisited. *Design Studies,* 26**,** 5-17.

COYNE, R. & SNODGRASS, A. 1995. Problem setting within prevalent metaphors of design. *Design Issues***,** 31-61.

CROSS, N. 1972. *Design participation,* Michigan, Academy Editions.

CROSS, N. 1982. Designerly ways of knowing. *Design Studies,* 3**,** 221-227.

CROSS, N. 2007. Forty years of design research. *Design Studies,* 28**,** 1-4.

CROWE, N. 1984. Studies in typology. *Journal of Architectural Education,* 38**,** 10-13.

CURRY, T. 2014. A theoretical basis for recommending the use of design methodologies as teaching strategies in the design studio. *Design Studies,* 35**,** 632-646.

DARKE, J. 1979. The primary generator and the design process. *Design Studies,* 1**,** 36-44.

DARKE, J. 1984. The primary generator and the design process. Developments in Design Methodology. New York: Nigel Cross.

DEFAZIO, J. 2008. *Designing with precedent: A cross-disciplinary inquiry into the design process.* Doctor of Philosophy, Indiana University.

DOBOLI, A. & UMBARKAR, A. 2014. The role of precedents in increasing creativity during iterative design of electronic embedded systems. *Design Studies,* 35**,** 298-326.

DORST, K. 2006. Design problems and design paradoxes. *Design issues,* 22**,** 4-17.

DORST, K. 2011. The core of 'design thinking'and its application. *Design studies,* 32**,** 521-532.

DORST, K. & CROSS, N. 2001. Creativity in the design process: co-evolution of problem–solution. *Design studies,* 22**,** 425-437.

DURAND, J. N. L. 1809. *Précis des leçons d'architecture données à l'École polytechnique,* Paris, chez l'auteur, à l'Ecole polytechnique.

ECK, C. V. 1998. The Structure of "De re aedificatoria" Reconsidered. *Journal of the Society of Architectural Historians,* 57**,** 280-297.

EILOUTI, B. H. 2009. Design knowledge recycling using precedent-based analysis and synthesis models. *Design Studies,* 30**,** 340-368.

EVBUOMWAN, N., SIVALOGANATHAN, S. & JEBB, A. 1996. A survey of design philosophies, models, methods and systems. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture,* 210**,** 301-320.

FALUDI, A. 1983. Critical Rationalism and Planning Methodology. *Urban Studies,* 20**,** 265-278.

FANG 1993. *A knowledge based computational approach to architectural precedent anlysis,* Delf, Publikatieburo Bouwkunde.

FLEMMING, U. & AYGEN, Z. 2001. A hybrid representation of architectural precedents. *Automation in Construction,* 10**,** 687-699.

FRENCH, M. J. 1985. *Conceptual design for engineers,* London, Springer-Verlag.

GLASER, B. G. & STRAUSS, A. L. 2009. *The discovery of grounded theory: Strategies for qualitative research,* New Jersey, Transaction Publishers.

GOFFMAN, E. 1974. *Frame analysis: An essay on the organization of experience,* Cambridge, MA, Harvard University Press.

GONÇALVES, M., CARDOSO, C. & BADKE-SCHAUB, P. 2014. What inspires designers? Preferences on inspirational approaches during idea generation. *Design studies,* 35**,** 29-53.

GROAT, L. & WANG, D. 2002. *Architectural research methods,* New York, Wiley.

GUBA, E. G. & LINCOLN, Y. S. 1994. Competing paradigms in qualitative research. *In:* DENZIN, N. K. & LINCOLN, Y. S. (eds.) *Handbook of qualitative research.* California: Sage.

GULGONEN, A. & LAISNEY, F. 1982. Contextual Approaches to Typology at the Ecole des Beaux-Arts. *Journal of Architectural Education,* 35**,** 26-28.

GÜNEY, Y., I. 2007. Type and typology in architectural discourse. *BAÜ FBE Dergisi,* 9**,** 3-18.

GUTSCHOW, K. K. Restructuring Architecture's History: Historicism in Karl Bötticher's Theory of Tectonics. (Re)Viewing the Tectonic Collegiate Schools of Architecture Regional Conference, 2000 University of Michigan.

HALE, J. A. 2005. Gottfried Semper's primitive hut as an act of self-creation. *Architectural Research Quarterly,* 9**,** 45-49.

HARRIS, A. 1980. Can design be taught. *Proceedings of Institution of Civil Engineers part,* 1**,** 68.

HATCHUEL, A. 2001. Towards Design Theory and Expandable Rationality: The Unfinished Program of Herbert Simon. *Journal of Management and Governance,* 5**,** 260-273.

HENRY HOME, L. K. 2007. *Sketches of the History of Man,* Indianapolis, Liberty Fund.

HERON, J. 1976. A six-category intervention analysis. *British Journal of Guidance and Counselling,* 4**,** 143-155.

HERRMANN, W. 1984. *Gottfried Semper: In Search of Architecture,* Cambridge, MA, MIT Press.

HEYLIGHEN, A., NEUCKERMANS, H., CASAER, M. & DEWULF, G. P. M. 2007. Building Memories. *Building Research and Information,* 35**,** 90-100.

HEYLIGHEN, A. & VERSTIJNEN, I. M. 2003. Close encounters of the architectural kind. *Design Studies,* 24**,** 313-326.

HILLIER, B., MUSGROVE, J. & O'SULLIVAN, P. 1972. Knowledge and Design. *In:* MITCHELL, W. J. (ed.) *Environmental Design Research and Practice.* University of California.

HUBKA, V. & EDER, W. E. 1988. *Theory of technical systems: A total concept theory for engineering design,* Berlin and New York, Springer-Verlag.

HUBKA, V. & EDER, W. E. 2012. *Theory of technical systems: a total concept theory for engineering design*, Springer Science & Business Media.

JACOBY, S. 2013. *The Reasoning of Architecture: Type and the Problem of Historicity.* Doctor of Philosophy, Technischen Universität Berlin.

JÄNSCH, J. & BIRKHOFER, H. The development of the guideline VDI 2221-the change of direction. DS 36: Proceedings DESIGN, the 9th International Design Conference, 2006 Dubrovnik, Croatia.

JENCKS, C. 2015. *In what style shall we build* [Online]. http://www.architectural-review.com/essays/in-what-style-shall-we-build/8679048.article?blocktitle=Top-Stories&contentID=11974: Architectural Review. [Accessed 13 March 2015].

JOHANSSON-SKÖLDBERG, U., WOODILLA, J. & ÇETINKAYA, M. 2013. Design Thinking: Past, Present and Possible Futures. *Creativity and Innovation Management,* 22**,** 121-146.

JOHNSON, P.-A. 1994. *The Theory of Architecture: Concepts Themes & Practices,* London, John Wiley & Sons.

KÄRRHOLM, M. 2013. Building type production and everyday life: rethinking building types through actor-network theory and object-oriented philosophy. *Environment and Planning D: Society and Space,* 31**,** 1109-1124.

KAUFMANN, E. 1957. *Architecture in the Age of Reason. Baroque and Post-Baroque in England, Italy and France,* Cambridge, MA, Harvard University Press.

KITWOOD, T. 1977. *Values in Adolescent Life: Towards a Critical Description.* University of Bradford.

KLEIN, A. 1934. Das Einfamilienhaus. *Südtyp: Studien und Entwürfe mit grundsätzlichen Betrachtungen*.

KOLODNER, J. L. 1992. An introduction to Case-Based Reasoning. *Artificial Intelligence Review,* 6**,** 3-34.

KRICK, E. V. 1965. *An introduction to engineering and engineering design,* London, John Wiley.

KRIER, R., SCHNERIDER, R. & VORREITER, G. 1988. *Architectural composition,* New York, Rizzoli

KRIPPENDORFF, K. & BUTTER, R. 2007. Semantics: Meanings and contexts of artifacts. *In:* SCHIFFERSTEIN, H. N. J. & HEKKERT, P. (eds.) *Product experience.* New York: Elsevier.

LATHOURI, M. 2011. The City as a Project: Types, Typical Objects and Typologies. *Architectural Design,* 81**,** 24-31.

LAUGIER, M. A. 1977. *An Essay on Architecture,* Los Angeles, Hennessey and Ingalls Inc.

LAVIN, S. 1992. *Quatremere de Quincy,* Cambridge, MA, MIT Press.

LAWSON, B. 2006. *How designers think: the design process demystified,* Oxford, Routledge.

LAWSON, B. R. 1979. Cognitive strategies in architectural design. *Ergonomics,* 22**,** 59-68.

LEHRDAL, E. 2001. *Staging for creative collaboration in design teams. Models, tools and methods.* NTNU.

LEUPEN, B. 2002. Concept and Type. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

LEWIS-BECK, M. S. 1993. *Experimental design and methods,* London, Sage Publications.

LIE, U. 2011. *Framing an eclectic practice; Historical models and narratives of product design as professional work.* Philosophiae Doctor, Norwegian University of Science and Technology.

LIKERT, R. 1932. A technique for the measurement of attitudes. *Archives of psychology*.

LINCOLN, Y. S. & GUBA, E. G. 1985. *Naturalistic inquiry,* London, Sage.

MAHER, M. L. & GÓMEZ DE SILVA GARZA, A. S. 1997. Case-Based Reasoning in Design. *IEEE Intelligent Systems,* 12**,** 34-41.

MAHER, M. L. & POON, J. 1996. Modeling design exploration as co‐evolution. *Computer‐Aided Civil and Infrastructure Engineering,* 11**,** 195-209.

MALLGRAVE, H. F. 1985. Review of Gottfried Semper: In Search of Architecture. *Journal of Architectural Education* 38**,** 33-34.

MARPLES, D. L. 1961. The decisions of engineering design. *Engineering Management, IRE Transactions on***,** 55-71.

MCCLEAN, D. 2009. *Embedding learner independence in architecture education: reconsidering design studio pedagogy.* Doctor of Philosophy, Robert Gordon University.

MCNEILL, P. & CHAPMAN, S. 2005. *Research methods,* Oxford, Psychology Press.

MEADOWS, D. H., MEADOWS, N. L., RANDERS, J. & BEHRENS, W. 1974. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind [By] Donella H. Meadows [And Others]. 2d Ed*, Universe Books.

MIES VAN DER ROHE, L. 1945. Court House Project, Plan. New York: MoMA.

MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative data analysis: An expanded sourcebook,* London, Sage.

MOBLEY, M. I., DOARES, L. M. & MUMFORD, M. D. 1992. Process analytic models of creative capacities: Evidence for the combination and reorganization process. *Creativity Research Journal,* 5**,** 125-155.

MONEO, R. 1978. On Typology. *Oppositions,* 13**,** 22-45.

MORENO, D. P., HERNÁNDEZ, A. A., YANG, M. C., OTTO, K. N., HÖLTTÄ-OTTO, K., LINSEY, J. S., WOOD, K. L. & LINDEN, A. 2014. Fundamental studies in Design-by-Analogy: A focus on domain-knowledge experts and applications to transactional design problems. *Design Studies,* 35**,** 232-272.

MORGAN, M. H. 1960. Vitruvius. *The ten books on architecture.* New York: Dover

MORRIS, E. K. 1980. Teaching history typologically. *Journal of Architectural Education,* 34**,** 27-28.

MORRIS, E. K. 1982. Architectural type and institutional programme. *Journal of Architectural Education,* 35**,** 17-25.

MOUSSAVI, F., CIANCARELLA, M., SCELSA, J. A., CRETTIER, M. & KILALEA, K. 2014. *The Function of Style,* Barcelona, Actar.

MULLER, W. & PASMAN, G. 1996. Typology and the organization of design knowledge. *Design Studies,* 17**,** 111-130.

MURBARAK, K. 2004. *Case Based Reasoning for Design Composition in Architecture.* Doctor of Philosophy, Carnegie Mellon University.

NELSON, B. A., WILSON, J. O., ROSEN, D. & YEN, J. 2009. Refined metrics for measuring ideation effectiveness. *Design Studies,* 30**,** 737-743.

NESBITT, K. 1996. *Theorizing a New Agenda for Architecture:: An Anthology of Architectural Theory 1965-1995*, Princeton Architectural Press.

NEWELL, A., SHAW, J. C. & SIMON, H. A. 1958. Elements of a theory of human problem solving. *Psychological review,* 65**,** 151.

NEWELL, A., SHAW, J. C. & SIMON, H. A. 1959. *The processes of creative thinking,* Santa Monica, CA, Rand Corporation

OECHSLIN, W. 1986. Premises for the Resumption of the Discussion of Typology. *Assemblage***,** 37-53.

OXMAN, R. & OXMAN, R. 1993. Remembrance of things past: design precedents in libraries. *Automation in Construction,* 2**,** 21-29.

PADOVAN, R. 2002. *Towards universality: Le Corbusier, Mies and De Stijl,* Oxford, Routledge.

PAHL, G., BEITZ, W., FELDHUSEN, J. & GROTE, K.-H. 2007. *Engineering design: a systematic approach*, Springer Science & Business Media.

PATON, B. & DORST, K. 2011. Briefing and reframing: A situated practice. *Design Studies,* 32**,** 573-587.

PFEIFER, G. & BRAUNECK, P. 2007. *Courtyard houses: a housing typology,* Berlin, Walter de Gruyter.

POPPER, K. 1963. *Conjectures and refutations,* London, Routledge and Kegan Paul.

POPPER, K. R. 1959. *The logic of scientific discovery,* London, Hutchinson.

PORPHYRIOS, D. 1991. *Classical architecture,* London, Andreas Papadakis Publisher.

QUATREMÈRE DE QUINCY, A. 1832. *Dictionnaire historique d'architecture,* Paris, le Clere.

RESTREPO, J., CHRISTIAANS, H. & GREEN, W. S. 2004. Give me an Example: Supporting the Creative Designer. *Computers in Art and Design*.

RITTEL, H. W. 1972. *On the Planning Crisis: Systems Analysis of the" First and Second Generations"*, Institute of Urban and Regional Development.

RITTEL, H. W. J. & WEBBER, M. M. 1973. Dilemmas in a General Theory of Planning. *Policy Sciences,* 4**,** 155-169.

ROETHLISBERGER, F. J. & DICKSON, W. J. 1939. *Management and the Worker,* Cambridge MA, Harvard University Press.

ROOZENBURG, N. & CROSS, N. 1991. Models of the design process: integrating across the disciplines. *Design Studies,* 12**,** 215-220.

ROOZENBURG, N. F. & EEKELS, J. 1995. *Product design: fundamentals and methods,* Chichester, Wiley.

ROSSI, A., EISENMAN, P., GHIRARDO, D. & OCKMAN, J. 1982. *The architecture of the city,* Cambridge, MA, MIT Press

ROWE, C. 1996. Program vs Paradigm. *The Cornell Journal of Architecture,* 1**,** 9-19.

ROWE, P. G. 1987. *Design Thinking,* London, MIT.

ROWLAND, I. D. & HOWE, T. N. 2001. *Vitruvius: 'Ten Books on Architecture'*, Cambridge University Press.

ROYAL INSTITUTE OF BRITISH ARCHITECTS. 2013. *Plan of Work* [Online]. RIBA. Available: https://www.ribaplanofwork.com/ [Accessed 23 May 2016].

SANOFF, H. 2007. Special issue on participatory design. *Design Studies,* 28**,** 213-215.

SCHEURICH, J. J. 1995. A postmodernist critique of research interviewing. *International Journal of Qualitative Studies in Education,* 8**,** 239-252.

SCHMITT, G. 1993. Case-Based Design and Creativity. *Automation in Construction,* 2**,** 11-19.

SCHÖN, D., A. 1984. Problems, frames and perspectives on designing. *Design Studies***,** 132-136.

SCHÖN, D., A. 1985. *The Design Studio,* London, RIBA Publications Ltd.

SCHON, D. A. 1992. Designing as reflective conversation with the materials of a design situation. *Research in Engineering Design,* 3**,** 131-147.

SCHWARZER, M. 1993. Ontology and Representation in Karl Botticher's Theory of Tectonics. *Journal of the Society of Architectural Historians,* 52**,** 267-280.

SHAH, J. J., SMITH, S. M. & VARGAS-HERNANDEZ, N. 2003. Metrics for measuring ideation effectiveness. *Design studies,* 24**,** 111-134.

SHIELDS, P. M. & TAJALLI, H. 2006. Intermediate theory: The missing link in successful student scholarship. *Journal of Public Affairs Education***,** 313-334.

SIMON, H. A. 1969. The Science of Design: Creating the Artificial. *The sciences of the artificial.* Cambridge, MA: MIT.

SIMON, H. A. 1977. The Structure of Ill-Structured Problems. *Models of Discovery.* Netherlands: Springer.

SIMON, H. A. 1996. *The sciences of the artificial,* Cambridge MA, MIT press.

SIO, U. N., KOTOVSKY, K. & CAGAN, J. 2015. Fixation or inspiration? A meta-analytic review of the role of examples on design processes. *Design Studies,* 39**,** 70-99.

SMITHIES, K., W. 1981. *Principles of Design in Architecture,* Berkshire, Van Nostrand Reinhold Company Ltd.

SNODGRASS, A. & COYNE, R. 1992. Models, metaphors and the hermeneutics of designing. *Design Issues***,** 56-74.

SPELMAN, E. R. 1997. *Gottfried Semper and profound surface of architecture.* Master of Architecture, Rice University.

STEADMAN, P. 1979. *The evolution of designs,* Oxford, Routledge

STEADMAN, P. & MITCHELL, L. J. 2010. Architectural morphospace: mapping worlds of built forms. *Environment and Planning B: Planning and Design,* 37**,** 197-220.

STEVENS, G. 1995. Struggle in the studio: A Bourdivin look at architectural pedagogy. *Journal of Architectural Education,* 49**,** 105-122.

SUH, N. P. 1990. *The principles of design,* New York, Oxford University Press

TATE, D. & NORDLUND, M. A design process roadmap as a general tool for structuring and supporting design activities. Proceedings of the Second World Conference on Integrated Design and Process Technology (IDPT), 1996. Citeseer, 1-4.

THORNLEY, D. G. 1962. Design Method in Architectural Education. *In:* JONES, J. C. & THORNLEY, D. G. (eds.) *Papers presented at the Conference on Systematic and Intuitive Methods in Engineering, Industrial Design, Architecture and Communications.* London: Pergamon.

TICE, J. 1993. Theme and Variations: A Typological Approach to Housing Design, Teaching, and Research. *Journal of Architectural Education,* 46**,** 162-175.

TOMIYAMA, T., TAKEDA, H., YOSHIOKA, M. & SHIMOMURA, Y. Abduction for creative design. ASME 2003 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference, 2003. American Society of Mechanical Engineers, 543-552.

TUNÇER, E. B. 2009. *The Architectural Information Map.* Doctor of Philosophy, Technische Universiteit Delft.

UNIVERSITY OF BATH. 2014. *Code of Good Practice in Research Integrity* [Online]. Bath: University of Bath. Available: http://www.bath.ac.uk/opp/docs/code-of-good-practice-in-research-integrity.pdf [Accessed 21/06/2016 2016].

URBAN, F. 2013. *Tower and slab: histories of global mass housing,* London, Routledge.

VDI. 1993. *Systematic approach to the development and design of technical systems and products* [Online]. Germany: VDI. Available: http://www.vdi.eu/nc/guidelines/vdi_2221-methodik_zum_entwickeln_und_konstruieren_technischer_systeme_und_produkte/ [Accessed 17 June 2016].

VESELY, D. 2004. *Architecture in the age of divided representation: the question of creativity in the shadow of production,* Cambridge MA, MIT press.

VIDLER, A. 1977. The third typology. *Oppositions,* 7**,** 288-294.

VINCENTI, W. G. 1990. *What engineers know and how they know it,* Baltimore, Johns Hopkins University Press.

VITRUVIUS 1960. *Ten books on architecture,* New York, Dover.

VITRUVIUS POLLIO, M. & GRANGER, F. 1983. *On architecture,* Cambridge MA, Harvard University Press.

VON MEISS, P. 2013. *Elements of architecture: from form to place,* Oxford, Routledge.

WAKS, L. J. 2001. Donald Schon's philosophy of design and design education. *International Journal of Technology and Design Education,* 11**,** 37-51.

WALDMAN, P. 1982. A Primer of Easy Pieces: Teaching through Typological Narrative. *Journal of Architectural Education,* 35**,** 10-13.

WATTS, R. D. 1966. The elements of design. *The design method.* Springer.

WICKSTRÖM, G. & BENDIX, T. 2000. The" Hawthorne effect"—what did the original Hawthorne studies actually show? *Scandinavian journal of work, environment & health***,** 363-367.

WILKINSON, M. 2016. Origin of Joint Course in Architecture and Civil Engineering at the University of Bath. *In:* EMMITT, S. & ADEYEYE, K. (eds.) *Integrated Design: Building our Future.* Bath: University of Bath.

WRIGHT, A. 2011. Critical Method: A pedagogy for design education. *Design Principles and Practices,* 5**,** 109-122.

WU, Y.-W. & WENG, K.-H. 2012. Using an analogical thinking model as an instructional tool to improve student cognitive ability in architecture design learning process. *International Journal of Technology and Design Education,* 23**,** 1017-1035.

YORKE, F. R. S. & GIBBERD, F. 1937. *The modern flat,* London, Architectural Press.

YÜREKLI, A. 2013. The six-category intervention analysis: a classroom observation reference. *ELT Journal,* 67**,** 302-312.

APPENDIX A: Phase 1 Design Briefs

General Brief

A space for thinking

Your friend has asked you to design a structure to help her think. Your friend is a philosopher and she needs somewhere to muse on the meaning of human existence.

She will use the structure all year round so it is imperitive that it can keep her warm and dry.

The structure has to contain the following spaces:

A space to eat.
A space to sleep.
A space to think.
A space to write.
A garden room, an enclosed external space which is open to the sky. This is the most important space of the building.

When she is in the building she must feel separated from the outside world, removed from the hustle and bustle of daily life and allowed to be alone with her thoughts.

The site

The structure needs to be designed to sit on a site that is 8m square and perfectly flat. The maximum height of the building is 4m. Your friend plans to buy a plot of land this size however is yet to do so, therefore the structure needs to be suitable for a variety of contexts. The structure can fill all or part of the site.

Requirements

You are required to draw a plan, section, elevation and 3D view (an aerial view or at eye level). Please use the spaces on the sheet provided.

Timescale

15 minutes - First brief introduction and reading of project briefs

30 minutes - Design exercise 1. Sketch your initial proposal in plan, section, elevation and in 3D (perspective, isometric or axonometric) in the boxes provided.

5 minutes - Second brief issued

30 minutes - Design exercise 2. Sketch your initial proposal in plan, section, elevation and in 3D (perspective, isometric or axonometric) in the boxes provided.

10 minutes - Evaluate design solution

20 minutes - Debrief

Notes

This exercise is NOT assessed. The purpose of the workshop is to explore different ways of designing. The quality of drawing and representation is not important and efforts should be focussed on making a coherent design solution.

Figure A1: Phase 1 brief X, written brief

Brief A **No additional requirements**

Figure A2: Phase 1 brief A, intentionally left blank

Brief B

Additional Requirements

Along with the initial brief, your friend has given you some images which she feels captures the essence of what the structure should be.

Figure A3: Phase 1 brief B, images of courtyards

Brief C

Additional Requirements

Along with the initial brief, your friend has given you some plans of buildings she particularly likes. She wants you to use these as the basis for the new building.

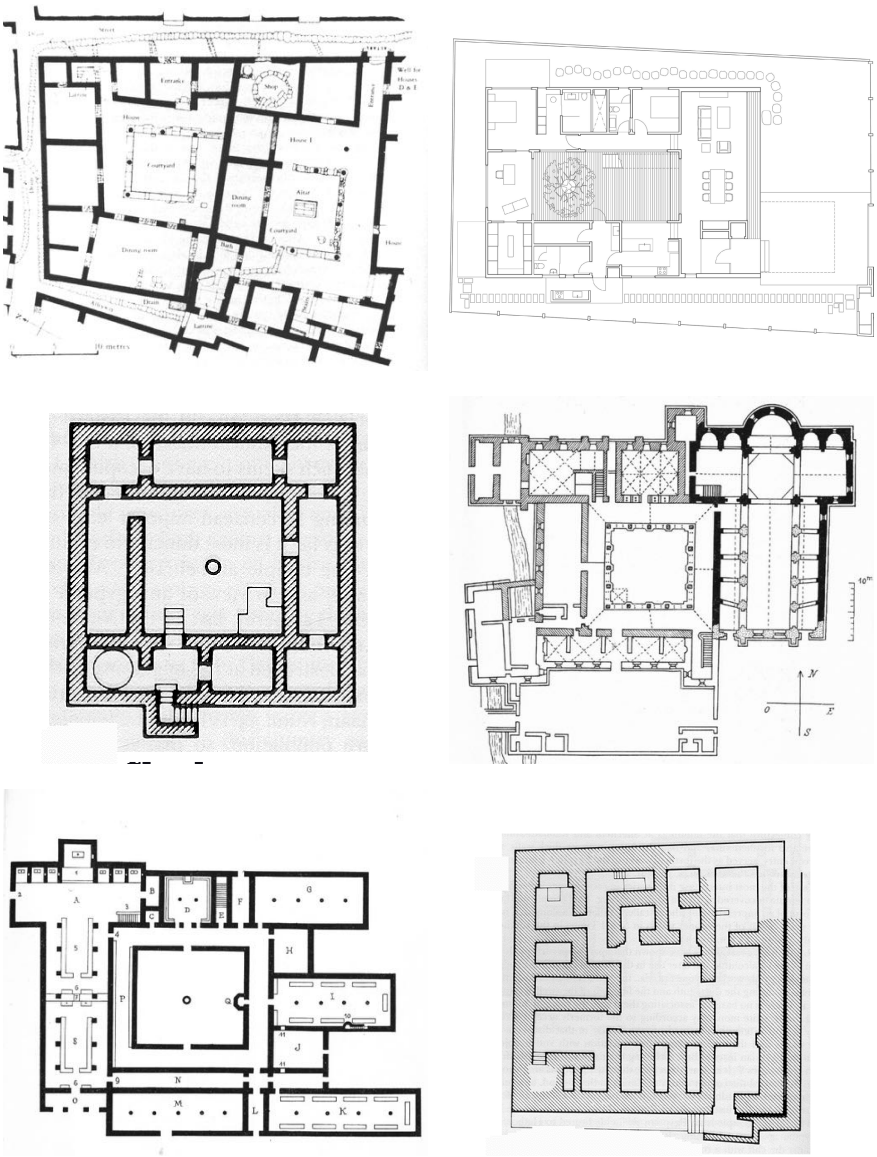


Figure A4: Phase 1 brief C, plans of courtyards

APPENDIX B: Phase 1 Data Analysis

		Design Exercise 1	Design Exercise 2	Design Exercise 1					Design Exercise 2							
Group Number	Student	Briefs Presented	Briefs Presented	EX01 Novelty (Garden Room)	EX01 Novelty (Spatial Arrangement)	EX01 Novelty (Separation)	**EX01 Novelty**	**EX01 Quality**	EX02 Novelty (Garden Room)	EX02 Novelty (Spatial Arrangement)	EX02 Novelty (Separation)	**EX02 Novelty**	**EX02 Quality**	**Novelty Improvement**	**Quality Improvement**	**Similarity between proposals**
A	1	C	X	7.00	7.00	10.00	**8.00**	**7.00**	7.00	7.00	10.00	**8.00**	**7.00**	**0.00**	**0.00**	9.00
A	2	C	X	3.00	3.00	7.00	**4.33**	**6.00**	3.00	3.00	10.00	**5.33**	**8.00**	**1.00**	**2.00**	7.00
A	3	C	X	3.00	7.00	3.00	**4.33**	**4.00**	3.00	7.00	7.00	**5.67**	**6.00**	**1.33**	**2.00**	9.00
A	4	C	X	3.00	3.00	3.00	**3.00**	**6.00**	3.00	3.00	3.00	**3.00**	**7.00**	**0.00**	**1.00**	7.00
A	5	C	X	10.00	10.00	10.00	**10.00**	**7.00**	10.00	7.00	10.00	**9.00**	**7.00**	**-1.00**	**0.00**	9.00
A	6	C	X	3.00	3.00	3.00	**3.00**	**6.00**	3.00	3.00	3.00	**3.00**	**4.00**	**0.00**	**-2.00**	7.00
A	7	C	X	10.00	7.00	3.00	**6.67**	**4.00**	7.00	10.00	10.00	**9.00**	**6.00**	**2.33**	**2.00**	7.00
A	8	C	X	3.00	3.00	3.00	**3.00**	**8.00**	7.00	3.00	3.00	**4.33**	**4.00**	**1.33**	**-4.00**	4.00
A	9	C	X	3.00	3.00	3.00	**3.00**	**3.00**	10.00	10.00	3.00	**7.67**	**4.00**	**4.67**	**1.00**	4.00
A	10	C	X	3.00	3.00	3.00	**3.00**	**8.00**	3.00	3.00	3.00	**3.00**	**8.00**	**0.00**	**0.00**	9.00
A	11	C	X	3.00	3.00	3.00	**3.00**	**4.00**	3.00	3.00	3.00	**3.00**	**6.00**	**0.00**	**2.00**	7.00
A	12	C	X	3.00	3.00	3.00	**3.00**	**5.00**	3.00	3.00	3.00	**3.00**	**6.00**	**0.00**	**1.00**	7.00
A	13	C	X	3.00	3.00	3.00	**3.00**	**6.00**	7.00	7.00	7.00	**7.00**	**7.00**	**4.00**	**1.00**	4.00
A	14	C	X	7.00	10.00	7.00	**8.00**	**4.00**	3.00	3.00	3.00	**3.00**	**7.00**	**-5.00**	**3.00**	2.00
A	15	C	X	10.00	7.00	10.00	**9.00**	**4.00**	10.00	3.00	7.00	**6.67**	**4.00**	**-2.33**	**0.00**	6.00
A	16	C	X	0.00	0.00	0.00	**0.00**	**3.00**	0.00	0.00	0.00	**0.00**	**1.00**	**0.00**	**-2.00**	7.00
A	17	C	X	3.00	3.00	3.00	**3.00**	**2.00**	3.00	3.00	3.00	**3.00**	**5.00**	**0.00**	**3.00**	7.00
A	18	C	X	10.00	10.00	10.00	**10.00**	**9.00**	10.00	10.00	10.00	**10.00**	**8.00**	**0.00**	**-1.00**	7.00
A	19	C	X	7.00	10.00	3.00	**6.67**	**5.00**	3.00	3.00	3.00	**3.00**	**8.00**	**-3.67**	**3.00**	7.00
A	20	C	X	3.00	3.00	3.00	**3.00**	**4.00**	3.00	3.00	3.00	**3.00**	**3.00**	**0.00**	**-1.00**	7.00
A	21	C	X	3.00	3.00	3.00	**3.00**	**5.00**	3.00	3.00	3.00	**3.00**	**7.00**	**0.00**	**2.00**	9.00
A	22	C	X	10.00	10.00	7.00	**9.00**	**4.00**	3.00	7.00	3.00	**4.33**	**7.00**	**-4.67**	**3.00**	7.00
B	1	B	X	10.00	10.00	10.00	**10.00**	**2.00**	3.00	3.00	10.00	**5.33**	**3.00**	**-4.67**	**1.00**	7.00
B	2	B	X	3.00	3.00	3.00	**3.00**	**2.00**	3.00	3.00	7.00	**4.33**	**2.00**	**1.33**	**0.00**	7.00
B	3	B	X	7.00	7.00	7.00	**7.00**	**3.00**	7.00	7.00	3.00	**5.67**	**6.00**	**-1.33**	**3.00**	6.00
B	4	B	X	10.00	10.00	10.00	**10.00**	**2.00**	10.00	10.00	10.00	**10.00**	**1.00**	**0.00**	**-1.00**	9.00
B	5	B	X	3.00	3.00	7.00	**4.33**	**4.00**	3.00	7.00	7.00	**5.67**	**7.00**	**1.33**	**3.00**	7.00
B	6	B	X	3.00	3.00	10.00	**5.33**	**3.00**	3.00	7.00	3.00	**4.33**	**7.00**	**-1.00**	**4.00**	7.00
B	7	B	X	10.00	7.00	10.00	**9.00**	**3.00**	10.00	7.00	10.00	**9.00**	**3.00**	**0.00**	**0.00**	9.00
B	8	B	X	10.00	7.00	10.00	**9.00**	**2.00**	7.00	10.00	7.00	**8.00**	**6.00**	**-1.00**	**4.00**	9.00
B	9	B	X	10.00	10.00	10.00	**10.00**	**4.00**	10.00	10.00	10.00	**10.00**	**4.00**	**0.00**	**0.00**	9.00
B	10	B	X	7.00	7.00	7.00	**7.00**	**5.00**	7.00	7.00	7.00	**7.00**	**6.00**	**0.00**	**1.00**	9.00
B	11	B	X	7.00	10.00	10.00	**9.00**	**4.00**	7.00	10.00	10.00	**9.00**	**7.00**	**0.00**	**3.00**	9.00
B	12	B	X	3.00	3.00	7.00	**4.33**	**5.00**	3.00	3.00	3.00	**3.00**	**6.00**	**-1.33**	**1.00**	7.00
B	13	B	X	7.00	3.00	3.00	**4.33**	**5.00**	7.00	3.00	3.00	**4.33**	**7.00**	**0.00**	**2.00**	9.00
B	14	B	X	3.00	3.00	3.00	**3.00**	**1.00**	3.00	3.00	3.00	**3.00**	**5.00**	**0.00**	**4.00**	9.00
B	15	B	X	3.00	3.00	7.00	**4.33**	**4.00**	10.00	10.00	10.00	**10.00**	**5.00**	**5.67**	**1.00**	2.00
B	16	B	X	3.00	3.00	7.00	**4.33**	**1.00**	7.00	7.00	7.00	**7.00**	**5.00**	**2.67**	**4.00**	7.00
B	17	B	X	7.00	7.00	7.00	**7.00**	**3.00**	7.00	7.00	7.00	**7.00**	**5.00**	**0.00**	**2.00**	7.00
B	18	B	X	10.00	10.00	10.00	**10.00**	**3.00**	7.00	10.00	10.00	**9.00**	**6.00**	**-1.00**	**3.00**	9.00
B	19	B	X	10.00	7.00	10.00	**9.00**	**2.00**	3.00	3.00	7.00	**4.33**	**7.00**	**-4.67**	**5.00**	7.00
B	20	B	X	3.00	3.00	3.00	**3.00**	**7.00**	7.00	7.00	7.00	**7.00**	**5.00**	**4.00**	**-2.00**	7.00
B	21	B	X	10.00	10.00	10.00	**10.00**	**4.00**	10.00	10.00	10.00	**10.00**	**6.00**	**0.00**	**2.00**	7.00
B	22	B	X	7.00	3.00	7.00	**5.67**	**5.00**	7.00	7.00	10.00	**8.00**	**6.00**	**2.33**	**1.00**	7.00
B	23	B	X	7.00	7.00	7.00	**7.00**	**5.00**	7.00	7.00	7.00	**7.00**	**6.00**	**0.00**	**1.00**	9.00
B	24	B	X	10.00	10.00	7.00	**9.00**	**3.00**	3.00	3.00	7.00	**4.33**	**7.00**	**-4.67**	**4.00**	4.00
C2	4	AX	B	3.00	3.00	7.00	**4.33**	**7.00**	3.00	3.00	7.00	**4.33**	**7.00**	**0.00**	**0.00**	9.00
C2	5	AX	B	10.00	7.00	7.00	**8.00**	**3.00**	7.00	7.00	10.00	**8.00**	**4.00**	**0.00**	**1.00**	2.00
C2	6	AX	B	10.00	7.00	3.00	**6.67**	**4.00**	7.00	7.00	7.00	**7.00**	**4.00**	**0.33**	**0.00**	4.00
C2	7	AX	B	7.00	10.00	10.00	**9.00**	**2.00**	10.00	7.00	7.00	**8.00**	**3.00**	**-1.00**	**1.00**	7.00
C2	11	AX	B	7.00	7.00	10.00	**8.00**	**4.00**	7.00	7.00	10.00	**8.00**	**5.00**	**0.00**	**1.00**	7.00
C2	12	AX	B	3.00	3.00	3.00	**3.00**	**8.00**	3.00	3.00	3.00	**3.00**	**8.00**	**0.00**	**0.00**	9.00
C2	13	AX	B	3.00	3.00	7.00	**4.33**	**7.00**	10.00	10.00	10.00	**10.00**	**4.00**	**5.67**	**-3.00**	2.00
C1	1	AX	C	3.00	7.00	3.00	**4.33**	**6.00**	3.00	3.00	3.00	**3.00**	**7.00**	**-1.33**	**1.00**	6.00
C1	2	AX	C	3.00	3.00	7.00	**4.33**	**7.00**	3.00	3.00	3.00	**3.00**	**8.00**	**-1.33**	**1.00**	7.00
C1	3	AX	C	3.00	10.00	10.00	**7.67**	**7.00**	3.00	10.00	10.00	**7.67**	**8.00**	**0.00**	**1.00**	7.00
C1	8	AX	C	3.00	7.00	3.00	**4.33**	**6.00**	3.00	3.00	3.00	**3.00**	**5.00**	**-1.33**	**-1.00**	7.00
C1	9	AX	C	3.00	3.00	7.00	**4.33**	**7.00**	3.00	3.00	7.00	**4.33**	**5.00**	**0.00**	**-2.00**	4.00
C1	10	AX	C	7.00	4.00	7.00	**6.00**	**6.00**	7.00	3.00	7.00	**5.67**	**6.00**	**-0.33**	**0.00**	9.00
C1	14	AX	C	7.00	3.00	7.00	**5.67**	**6.00**	7.00	3.00	10.00	**6.67**	**5.00**	**1.00**	**-1.00**	7.00

Table B1: Phase 1 assessment of design tasks

Key

Brief X	General Brief
Brief A	No additional information
Brief B	Images
Brief C	Plans

		Mean	Median	Mode	Standard Deviation
Assessment 1A	Similarity	6.77			1.85
	Novelty	4.95	3.00	3.00	2.89
	Quality	5.18	5.00	4.00	1.82
Assessment 1B	Similarity	7.46			1.74
	Novelty	6.86	7.00	10.00	2.58
	Quality	3.42	3.00	3.00	1.47
Assessment 1C (control)	Novelty	5.71	5.00	4.33	1.86
	Quality	5.71	6.00	7.00	1.77
Assessment 2A	Novelty	4.86	3.67	3.00	2.64
	Quality	5.18	6.50	7.00	1.87
Assessment 2B	Similarity				
	Novelty	6.76	7.00	4.33	2.31
	Quality	5.33	6.00	6.00	1.66
Assessment 2C1	Similarity	6.71			1.50
	Novelty	5.24	4.33	4.33	1.29
	Quality	5.24	4.33	4.33	1.29
Assessment 2C2	Similarity	5.71			3.04
	Novelty	6.19	6.67	4.33	2.30
	Quality	6.19	6.67	4.33	2.30

Table B2: Phase 1 summary table by assessment

	NOVELTY				
		Group A	Group B	Group C	
				Group C1	Group C2
Assessment 1	1st Brief	Plans	Images	Requirements	
		4.95 (2.89)	6.86 (2.58)		5.71 (1.86)
Assessment 2	2nd Brief	Requirements	Requirements	Plans	Pictures
		4.86 (2.64)	6.76 (2.31)	5.24 (1.29)	6.19 (2.30)
	Improvement mean	-0.09	-0.10	-0.48	0.71
	Improvement SD	2.33	2.43	0.90	2.22

	VARIETY				
		Group A (SD)	Group B (SD)	Group C (SD)	
				C1	C2
Assessment 1	1st Brief	Plans	Images	Written	
		3.9	4.26	5.54	
Assessment 2	2nd Brief	Written	Written	Plans	Images
		3.81	4.22	5.83	8.33
Group variety change		-0.1	-0.04	0.29	2.79

	QUALITY				
		Group A	Group B	Group C	
				Group C1	Group C2
Assessment 1	1st Brief	Plans	Images	Requirements	
		5.18 (1.82)	3.42 (1.47)		5.79 (1.85)
Assessment 2	2nd Brief	Requirements	Requirements	Plans	Pictures
		5.18 (1.87)	5.33 (1.66)	5.34 (1.29)	6.00 (3.21)
	Improvement mean	0.73	1.92	-0.14	0.00
	Improvement SD	1.88	1.82	1.21	1.41

Table B3: Phase 1 summary tables by metrics

		Design Exercise 1	Design Exercise 2		Design Exercise 1		Design Exercise 2						
Group Number	Student	Briefs Presented	Briefs Presented	I feel I successfully fulfilled the overall brief	EX01 The additional brief restricted my creativity	EX01The additional brief helped me solve the problem set	EX 02 The additional brief restricted my creativity	EX02The additional brief helped me solve the problem set	I feel I would have performed better having received the briefs in a different order	I feel I would have performed better having received both briefs simultaneously	I feel I would have performed better having received no additional information	I feel the design task improved my general ability to generate applicable design solutions	Comments/Notes
A		1 C	X	2	3	2			4	4	5	2	1x A4 Additional sketches, some material consideration
A		2 C	X	2	4	2	4	1	2	1	4	2	Varied plan form but similar in elevation
A		3 C	X	2	5	2			4	4	5	2	
A		4 C	X	2	4	2			3	2	5	2	Reverted to introduction of additional spaces including labelling 'office'
A		5 C	X	3	4	2	4	2	4	3	4	2	
A		6 C	X	2	4	2	4	2	4	2	5	2	
A		7 C	X	3	2	2			4	4	2	2	
A		8 C	X	2	4	2	4	2	4	4	5	3	rearrangement of plan to weaker design - practical constraints inhibited design
A		9 C	X	2	4	2	4	2	3	4	4	4	
A		10 C	X	2	4	2			2	3	5	3	expressed desire of practical purpose
A		11 C	X	2	4	2	4	2	4	2	4	3	not enough time
A		12 C	X	2	4	2	4	2	3	4	5	2	
A		13 C	X	2	4	2	4	2	3	3	4	2	
A		14 C	X	2	3	3	4	2	4	3	4	2	
A		15 C	X	2	4	2	4	2	4	2	4	2	
A		16 C	X	4	4	3	4	2	4	3	4	2	
A		17 C	X	4	4	3	2	2	4	3	2	2	
A		18 C	X	2	5	1	5	1	3	1		3	More holistic approach preferred
A		19 C	X	3	5	2			3.5	3.5	5	2.5	precedents increased ideas and made more focused thinking in a specific way
A		20 C	X	1	4	4			5	5	2		restriction is starting point of creation
A		21 C	X	2	5	2	3	2	3	2	3	2	
A		22 C	X	1	3	2	4	2	1	1	5	4	took more esoteric influences from precedent, - fun but no point
B		1 B	X	3	4	2	4	2	4		2	2	Written interpretation of brief but unable to translate ides to drawing, blob like form unrelated to precedents, 1 x a4 of sketches
B		2 B	X	3	3	2	3	2	3	2	4	2	Annotations interpret images only stylistically eg plants, sloped roof, arches etc - failed to grasp underlying type
B		3 B	X	3	4	2	4	1	3	3	5	2	commented that the images gave a sense of atmosphere, and images did not act as a constraint
B		4 B	X	2	5	3	3	2	5	5	4	2	No identification of courtyard - reverted to known type of a house form
B		5 B	X	1	4	2			2	1	5	2	
B		6 B	X	2	4	1			4	4	5	2	
B		7 B	X	2	3	3			4	2	4	4	
B		8 B	X	2	4	2			3	2	4	2	
B		9 B	X	2	4	1			4	4	3	3	
B		10 B	X	2	5	1			3	2	5	1	
B		11 B	X	2	4	2	4	2	3	4	4	4	
B		12 B	X	4	4	2	4	2	3	4	4	2	Ccomments haven't finished yet
B		13 B	X	2	5	1	4	3	5	5	5	4	limages considered very helpful
B		14 B	X	2	2	3			2	2	4	2	
B		15 B	X	2	4	2	3	2	4	4	4	2	
B		16 B	X	2	4	3	3	4	5	5	5	2	
B		17 B	X	3	4	2	4	2	3	3	4	2	
B		18 B	X	3	4	3	4	2	3	2	3	4	prefers to be shown design examples that work - considered childish
B		19 B	X	2	4	2	4	1	3	2	4	3	
B		20 B	X	2	4	3	4	3	4	4	4	3	Allowed creativity - initialproblem would have limted creativity
B		21 B	X	2	4	3	4	2	2	2	4	2	
B		22 B	X	2	4	2	4	2	3	3	4	2	Liked fitting design to brief
B		23 B	X	2	4	2	4	2	3	3	4	2	Liked doing overall design before hand
B		24 B	X	2	4	2	4	2	4	4	4	2	Useful
C2		4 AX	B	2	4	4	4	2	4	3	4	2	Lack of limitations considered a restriction
C2		5 AX	B	3	5	2	5	1	1	1	5	1	Second brief helped prodiuce wquick solutions and organise space. We should do this more often!
C2		6 AX	B	3	5	3	4	3	4	4	4	3	Feels receiving more info earlier would suppress the design process

C2	7 AX	B		3	4	5	4	2	3	2	4	3	Thank you - a nice session. Info helped narrow ideas
C2	11 AX	B		3	5	5	4	3	2	4	4	2	helped improve ideas to think quickly
C2	12 AX	B		2	5	3	3	2	4	3	4	2	Not sure whether alterations in idea were good or bad, inspirational images helped, copied visual cues
C2	13 AX	B		2	5		5		4	4	4	2	adding more 'problems' helped progression, guidance helped
C1	1 AX	C		2	5	4	4	4	4	4	5	2	Helped speed of design - liked working to parameters
C1	2 AX	C		2	5	5	4	2	2	5	4	2	
C1	3 AX	C		2	4	4	5	2	5	2	4	3	Empty brief not seen as helpful. Second brief was
C1	8 AX	C		3	5	2	2	3	2	4	4	2	Hard to generate ideas without guidance, one brief then other helps iterate design
C1	9 AX	C		2	5	2	2	4	4	4	2	2	extra brief limited creativity
C1	10 AX	C		2	4	2	4	2	5	4	5	3	
C1	14 AX	C		3	4	2	2	4	4	2	4	4	Could not extract information from non-function based houses, lack of distillation.

Table B4: Phase 1 Student feedback

Key

1	Strongly Agree
2	Agree
3	Not Sure
4	Disagree
5	Strongly Disagree

APPENDIX C: Phase 2 Data Analysis

Category	Code
Objective 1: Framework	**FR**
Overall Strategy	FR-STRAT
Timing	FR-TIME
Relevance	FR-REL
Structure	FR-STRUCT
Objective 2: Pedagogic Techniques	**TE**
Workshop format	TE-FORM
Method of teaching/delivery	TE-METH
Practical Issues	TE-PRACT
Engagement	TE-ENG
Session length	TE-LENG
Techniques	TE-TECH
Objective 3 : Typologies	**TY**
Frame Definition	TY-FRAME
Concept Design	TY-CONC
Detail Design	TY-DE
Modifiers	
Positive response	POS
Negative response	NEG
Translation of ideas	TRANS
Deterministic Understanding	DET
Concept choosing	CONC
Resources	RES
Focused and sharp	FOC
Project space	PROJ
Relevance	REL
Specific/individual	IND
Undersatnding	UND
Confirmtion	CONFIRM
Precedent use	PRECE
Resolution	RESOLVE
Analysis	ANALY
Pace of workshops	PACE
Typology	TYPE
Brief	BRIEF
Conjectural process	CONJEC
Motivational	MOT
Ispiration	INSP
Process	PRO

Earlier	EARL
All sessions	ALL
Later	LATE
Instructor lead presentation	PRESENT
Group work	GROUP
Individual wotk	OWN
Spatial ideas	SPATIAL
Detail ideas	DETAIL
Abstract ideas	ABSTRACT
Database	DATABASE
Technical knowledge	TECH

Table C1: Analysis codes

Phase 2 Workshop 1: 14 March 2016

Student	What do you feel the purpose of the session was?	Has the session help you select relevant precedents?	What was successful?	What could be improved?
1	Understand who the client is and how best to build for them/select relevant precedents [TY-FRAME-DET (brief)]	Yes [TY-FRAME-POS]	Forming an idea of the client's needs/interests/personality [TY-FRAME-DET]	Have people pass around precedents more so I can see more in a shorter time [TE-PRACT-RES]
2	Have a precise idea of who the client is and how to translate this to architecture [TY-FRAME-TRANS] Understand and choose our main design focus [TY-FRAME-CONC]	Yes [TY-FRAME-POS]	Quick thinking, very targeted [TE-ENG-FOC]	A bit more individual. [TY-FRAME-REL] [TE-METH-IND] Not sure how finding the different typologies/subcategories helped [TY-FRAME-UND]
3	Understanding the brief, client and themes to help the generation of design and focus us [TY-FRAME-DET (brief)] [TE-ENG-FOC]	Mostly although haven't founds of relevant ideas [TY-FRAME-NEG] [TY-FRAME-CONC/CONJEC]	Learnt how to pinpoint the values of my building which will be important to the design and how they correspond to the user [TY-FRAME-DET (brief)]	More books [TE-PRACT-RES]
4	Clarify brief and determine precedents quickly to start design [TY-FRAME-DET (brief)] [TY-FRAME-PRECE]	Yes (Can Lis, Utzon) [TY-FRAME-POS] [TY-FRAME-PRECE/CONJEC]	Understanding the brief and getting us to decide on the brief efficiently so that we can focus on design [TE-ENG-FOC] [TY-FRAME-DET (brief)]	More books and less paper so we can just photocopy what we need [TE-PRACT-RES]
5	To analyse the task thouroughly and thereafter to lay a strong base of the further design [TY-FRAME-ANALY] [TY-FRAME-DET	Yes it was very helpful. Thankyou very much! [TY-FRAME-POS]	Since the time was limited, I had to make good decisions very quickly which avoids the chances to waste time on thinking of unnecessary	The images of precedents are not in colour which was difficult to look at [TE-PRACT-RES]

	(brief)] [TE-ENG-PROJ]		elements. [TE-ENG-FOC] Also because we moved very quickly a lot of information and knowledge was delivered efficiently	
6	To quickly form the brief for the project by breaking down a seemingly difficult beginning of the project into several simpler stages [TY-FRAME-DET/ANALY (brief)]	Yes indeed as it helped me lay all the desirable criteria/typologies and types that I'm looking for. [TY-FRAME-TYPE]	Helped me get straight into the middle of the project such that I can get started with coming up with designs straight away. [TE-ENG-FOC] [TE-ENG-PROJ/CONJEC]	Left blank
7	To help us decide who the client is and what we want to give importance to in the house [TY-FRAME-DET (client)]	Yes [TY-FRAME-POS]	The aim of the project is now clearer [TE-ENG-FOC] [TE-ENG-PROJ]	A little more time [TE-LENG]
8	Come up with main ideas for the home which are related to the characteristics of a specific chosen photographer [TY-FRAME-CONJEC]	Yes. Looking through the projects gave me more ideas than the house [TY-FRAME-POS] [FR-REL] TE-ENG-PROJ/CONJEC]	Gave me more detailed information about the project and direction of what to do next clear TE-ENG-PROJ]	Left blank

Table C2: Workshop 1 participant feedback

Workshop 1 Field Notes

Interpretation of the written brief was challenging with some students. This hindered attempts to translate this to typologies quickly. There was also worry about achieving the correct brief [TY-FRAME-BRIEF]
Quality of visual mmaterial was very important. Students spent time reading and interpreting visual material thus affecting how quickly they could cycle through information in a the session. [TE-LENG] [TE-PRACT-RES] [TY-FRAME-UND]
Extracting architecturally relevant characteristics was challenging [TE – FRAME – UND]
Not having done prior work (prerequisite to the session – eg watching the videos) [TE – STRUCT – MOT]
Providing an initial example was helpful and lead to quick adoption of the tasks. [TE-METH]
Forces focus and production of work [TE-ENG-FOC]
Few students were able to identify and key typologies, articulate these as typologies despite the exercise. [TY-FRAME- UND]
Post it exercise led to good group interaction and cohesion however quieter students had to be facilitated. [TY-FRAME- UND] [TE-ENG]
Facilitator played a crucial role in defining typologies and encouraging group engagement [TE-METH] (role of facilitator)
Took time to gain momentum [TE-TIME]
Lack of clarity in some cases. Often it was not clear exactly how to group student created types and the instructor was unable to lead or direct the group. This may be to either unrecognized types or misunderstanding of the problem by the students. [TY-FRAME- UND] [TE-METH] [TE-FORM]
Problems identifying relevant types [TY-FRAME- UND]
Lack of visual stimulus in post-it note exercise formed a challenge to the direct association with types [TE-METH] [TE-PRACT]
Few acknowledged types or formal types eg Basilica, courtyard, etc [TY-FRAME-YPE] [PERHAPS TYPE FORMATION BEGINNING WITH PRECEDENTS MAY BE MORE HELPFUL EG SELECT RELEVANT PRECEDENTS THEN TRANSFORM THEM INTO TYPES]
Mostly linked by surface characterisitcs [TY-FRAME- UND]
It was challenging as a tutor to facilitate the session as students consider the tutor as a source of definitive knowledge.

Interpretation

Initial design exercise challenging trying to bridge the gap between written brief and grasping of types as primary generators.
Maybe more useful for students to find precedents first then form types based on those precedents however issues.
Students focus on analysis of brief rather than translating it to a type
Quality of visual material is paramount to the session!
Begin by taking about types in general – more introduction required?

Student	What was helpful about last week's session to help you begin your building?	What was unhelpful about last week's session to help you begin your building?	What could be improved about last week's session?
1	Working out quickly who my house was for and what was important to them in the design [TY-FRAME-DET (brief)]	Overall spent more time thinking and not doing/researching so hadn't found relevant precedents by the end of the day [TE-LENG] [FR-REL]	More books and resources [TE-PRACT-RES]
2	To pinpoint the story of the couple (type of photography etc. Precedents [TY-FRAME-TYPE] [TY-FRAME-PRECE] Congratulations for having memorized all of our names!	BLANK	Be more precise about which aspects of the precedents could be applied to our brief [TY-FRAME-UND] [TE-METH] Talk more about the courtyard aspect [TE-METH] [FR-REL]
3	As we had decided on the precedents and the typology it was helpful for us to start designing the house [TY-FRAME-TYPE] [TY-FRAME-PRECE/CONJEC]	I was not too sure about the structure that I could build with bricks and masonry [TY-FRAME-UND]	If we had talked a bit about designing and making the actual house it would have been slightly more helpful [TY-FRAME-UND] – lack of understanding of how types and design might relate
4	Use of precedents to give sense of direction to project [TY-FRAME-TYPE] [TY-FRAME-PRECE/CONJEC/TRANS]	Looking at lots of ideas meant I wasn't sure what to focus on [TE-METH] [TY-FRAME - UND]	Looking at possible links between photographers and precedents to tie everything together [TE-METH] [TE-STRUCT]
5	Precedents gave me ideas of planning the arrangement of spaces [FR-REL] [TY-FRAME-PRECE/CONJEC] Enabling me to be very focused on the design part rather than struggling with the job of the client	BLANK	I can't think of anything. Maybe a bit more guidance on landscape design [FR-REL]
6	Helpful to explore typological precedents early on [FR-REL] [TY-FRAME-PRECE]	Not many precedents useful [TE-PRACT-RES] [FR-REL] [TE-METH-REL/CONJEC]	BLANK
7	Looking at different typologies helped me to think about how I should layout my building [TY-FRAME-TYPE/CONJEC]	BLANK	Dimensions of different areas [FR-REL]

Table C3: Workshop 1 participant feedback (on reflection)

Interpretation

Typological focus more profound in hindsight [TY-FRAME-TYPE]

Need to link the exercises to practical aspects of the design process. Perhaps more introduction, talking about the design task or more set goals from how to take typologies and make a design once formed by students. Tying together of ideas a common theme. Demonstrated students unable to link abstract ideas to built forms [TY-FRAME-UND]

Too many ideas could be confusing so again need to direct and focus study – the facilitator acts as a filter or lens. [TY-FRAME-UND]

Phase 2 Workshop 2: 14 March 2016

Student	What do you feel the purpose of the session was?	Has the session help you select relevant precedents?	What was successful?	What could be improved?
1	To get a better understanding of spatial arrangement so that to get a clearer idea of our own plans [TY-CONC-DET/ANALY] spatial focus not linked to typologies	Yes [TY-CONC-POS]	The idea of a simple diagram of a plan is very helpful for me to get a straightforward idea of how spaces are arranged [TY-CONC-REL/PRO/ANALY]	I was sitting too far away and couldn't really see people's diagrams on the other side of the table [TE-PRACT]
2	Come up with simple scheme for a plan [TY-CONC-REL/PRO/CONJEC] Learn how to do simple diagrams Understand that house is primarily about living and not about aesthetics [TY-CONC-UND/ANALY] Realisation of universality of housing types	Perhaps [TY-CONC-NEG]	Learning how to make simple diagrams [TY-CONC-REL/PRO/ANALY]	You have an extremely organized timeline but everyone progresses differently Perhaps more flexibility [TE-FORM-PACE]
3	To select precedents and understand the basic design of our house [TY-CONC-PRECE]	Yes [TY-CONC-POS]	I selected relevant precedents and understood their basic functions [TY-CONC-PRECE] [TY-CINC-UND]	If we could work more on the diagram of our models [TY-CINC-IND] [TE-FORM-PACE]
4	To break down our design into simple types [TE-CONC-TYPE/ANALY]	Yes [TY-CONC-POS]	Analysing our design and simplifying their forms [TY-CONC-REL/PRO/ANALY]	Nothing [TY-CONC-POS]
5	Understand circulation and organization of plans [TY-CONC-DET/ANALY] spatial focus not linked to typologies	Yes, I know precisely what to look for now [TY-CONC-UND]	I understand how to simplify a plan to its core principles to help understand why the design works [TY-CONC-REL/PRO/ANALY]	All was good [TY-CONC-POS]
6	Help us	Kind of [TY-	To allow us to	BLANK

	categorize different structural plans [TY-CONC-DET] [TY-CONC-TYPE/ANALY]	CONC-NEG]	think about plans in a simple way [TY-CONC-UND]	
7	Think about circulation using the plan [TY-CONC-DET/UND/ANALY]	BLANK	Helped me to think about how the spaces are linked to the courtyard [TY-CONC-DET/PRO]	BLANK

Table C4: Workshop 2 participant feedback

Interpretation

Most criticism regarding format of session (seating arrangement and universal timings).

Diagraming precedents found very helpful and reducing scheme to a typological idea.

It appears less the direct relationship of own scheme to precedents that was of value but the demonstration that complexity can be summed up in simple diagram

Workshop 2 Field Notes

Diagrams occassionaly too detailed (students unsure about detail amount and revert to just copying plan) [TY-CONC-UND/TRANS]
Most showed spaces and circulation arrangement [TY-CONC-UND/REL]
Most avoided too much literal detail but with guidance from facilitator [TE-METH-PRO]
Guided establishment of types helped for weaker learners to form understanding. [TE-ENG-PRO]
Revealed complexity in some designs and lead to clearer strategic development
Diagramming not necessarily linked to types – almost seen as 2 separate exercises and did not generally lead to establishment of relevant precedents however diagramming could be seen as an act of categorization/reduction? [FR-STRUCT] [TY-CONC-TYPE]
Some found hard to distill design to important information and guidance as needed. [TE-ENG-PRO]
Design presented showed little relationship to precedents in previous week. Students did not present precedents alongside. [FR-STRAT]

Interpretation

Introducing types as an analytical tool appears effective
Students appreciate value of previous session once they have begun their designs
Types acting as a primary generator (ie trying to force primary generators) seems unsuccessful and become more valuable when the process of conjecture has already begun (thus an analytical tool)
It needs to be made clear how the exercises relate directly to their design process. Novice designers with inexperience of the design process are less able to see how eclectic processes may influence their work.
Does this corroborate conjecture/analysis or analysis/synthesis model?
Suggests attempting to analyses pre design to inform primary generators is unrealistic. Students do not synthesise based on analysis but appear to conjecture often ignoring pre-analysis. Thus as an analytical tool typology seems more valuable. Students must discover their own typologies through conjecture.

Phase 2 Workshop 3: 11 April 2016

Student	What do you feel the purpose of the session was?	Has the session help you select relevant precedents?	What was successful?	What could be improved?
	Think thoroughly about nature aesthetics and implication of openings and precedents [TY-DE-PRECE] [TY-DE-UND]	Hopefully [TY-DE-POS]	Use of precedents. [TY-DE-PRECE], beautiful organized powerpoint [TE-METH/FORM]	Add name architect and location of precedents [TE-PRACT/RES]
	I feel the purpose was to make us think clearly about how we place our openings and their details [TY-DE-UND]	Yes [TY-DE-POS]	I now have a clear idea about the placement of my openings[TY-DE-POS]	Could have spent time discussing the design aspect of the structure [TY-DE-REL]
	Find clarity in the openings of our design, [TY-DE-UND] Set up guidelines to improving our opening designs [TY-DE-IND/PRO]	Yes [TY-DE-POS]	[LEFT BLANK]	[LEFT BLANK]
	Consider different types of openings in our designs [TY-DE-IND/PRO]	Yes [TY-DE-POS]	Have more understanding about different ways to create effective openings [TY-DE-UND]	[LEFT BLANK]
	To categorise and better understand facades and openings to use in our schemes [TY-DE-IND/PRO]	Yes [TY-DE-POS]	Helped me to understand which openings would fit my scheme best [TY-DE-UND]	More images of examples [TE-RES]
	To think about positions of openings and consider types of openings and how they may affect the overall impression of the building [TY-DE-IND/PRO]	Yes, helped me simplify the categories of openings [TY-DE-POS/ANALY]	The powerpoint was helpful to understand how types of openings would look on my design [TY-DE-UND/ANALY]	More examples [TE-RES]
	Understand how to design openings in the	Yes	It's helped me to understand what works with my	Do this session earlier since my model mostly

	facades as they are significant in describing the personality of your building [TY-DE-PRO/UND]	design and maybe what needs to be analysed further Now I actually understand my design and where to go next [TY-DE-ANALY/UND]	shows the design of the facades and took ages so will take a long time to adapt [FR-STRUCT/TIME]

Table C5: Workshop 3 participant feedback

Interpretation

Understanding is a key concept that keeps arising

Appears to help students give meaning and understanding by identifying with types. Through identification meaning is assigned and understanding engendered

More precedents preferred

Less focus on conjecture and much more on types of openings as an analytical tool – no students mentioned how helpful this exercise was in generating ideas

Workshop 3 Field Notes

Helpful to intersperse presentations with student feedback.

Forces consideration and feedback [TY-DE-UND]
Valuable at revealing inconsistencies in designs [TY-DE-IND/ANALY]
Gave strategy to those lacking direction by association with a type [TY-DE-ANALY/PRO]
Physical detail 'types' can be easily and simply classified which was helpful from an instructor perspective. Easier to arrange and structure the session however requires pre-tutor preparation. [TE- FORM]
Lack of engagement from some students – boredom in presentation and some students had to be prompted into answers [TE- ENG]

Interpretation

Isolating specific typologies gave focus to the session This approach is probably only appropriate when specific detail information is required
No attempts to translate abstract ideas but rather the session was used to provide examples of strategies. In this sense, students chose their paths but the 'types' were tutor lead. Probably only appropriate where a finite number of solutions exist rather than open ended issues at the beginning of a project.
Explicit categorization appeared to help student engagement.

Phase 2 Workshop 4: 18 April 2016

Student	What do you feel the purpose of the session was?	Has the session help you select relevant precedents?	What was successful?	What could be improved?
	Finalise design by considering how to use bricks to create different effects for my façade [TY- DE-ANALY/RESOLVE]	Yes [TY- DE-POS]	Further development of my design [TY- DE-PRO]	[LEFT BLANK]
	Confirm last changes on design [TY- DE-CONFIRM] Answer questions about model, report and drawings [TY- DE-RESOLVE]	Not really because the design of the openings was already finished [TY- DE-NEG] [FR-TIME]	Tackled all uncertainties on finishing the whole project [TY- DE-RESOLVE]	[LEFT BLANK]
	Get us to think about the overall finish and atmosphere of the building and how to represent that [TY- DE-ANALY]	Helped develop a strategy for representing the building in hand drawings [TY- DE-REL]	Realised the potential of using pencil drawings [TY- DE-INSP]	Perhaps use the presentation earlier in the project [FR- TIME]
	To finalise façade and openings [TY-DE-RESOLVE]	Slightly [TY- DE-POS]	Clear images and good choice of buildings to get the point across[TE-METH/TECH-RES]	It may have been a little late in the project to make significant changes [FR- TIME]
	To produce a better report [TY- DE-RESOLVE]	Yes [TY- DE-POS]	I was introduced to new ideas of brick arrangement [TY- DE-INSP]	I was sitting quite far away and could not see the computer screen [TE- PRACT]
	Brick patterns [TY- DE-CONJECT]	Not at this point [TY- DE-NEG] [FR- TIME]	The beautiful powerpoint [TE- PRACT-RES]	We only have 1 week – we can't really make changes now [FR- TIME]
	To investigate new styles of illustrating our perspectives and drawings [TY- DE-INSP] To consider ways to express the brickwork [TY-	I'm more certain about my strategy now that other ideas I had are not worth including [TY- DE-CONFIRM]	I am inspired to create my perspective and know what needs replacing in my portfolio [TY- DE-INSP]	Not much, good job [TY- DE-POS]

	DE-ANALY/RESOLVE] To understand how to set up a successful portfolio style [TY-DE-UND]	

Table C6: Workshop 4 participant feedback

Workshop 4 Field Notes

Students respond well to images and inspirational material [TY- DE-INSP]
At this late stage, offering confidence is more effective than suggesting improvements from a student perspective. [TY- DE-CONFRIM] (not enough perceived time to make significant changes [TY- DE-NEG])

Much less focus on types or ways of using types. [TY- DE-REL] Perhaps too late (USER FEEBACK SUGGESTS) or types at this stage break down as too many variations. [TY- DE-IND]
Students lack motivation at this point in the project [TE- EN-MOT] and respond best to inspirational material that they can see easily incorporated. [TY- DE-INSP]
Very little uptake of detail typologies – generally understood to be irrelevant [TY-DE-REL] or corroborate existing ideas [TY- DE-CONFRIM/ANALY]

Interpretation

Less successful session, proved more helpful at increasing confidence and providing inspiration rather than offering meaningful understanding of types
Lack of success probably due to timing of session.

APPENDIX D: Phase 2 Analysis of Design Projects

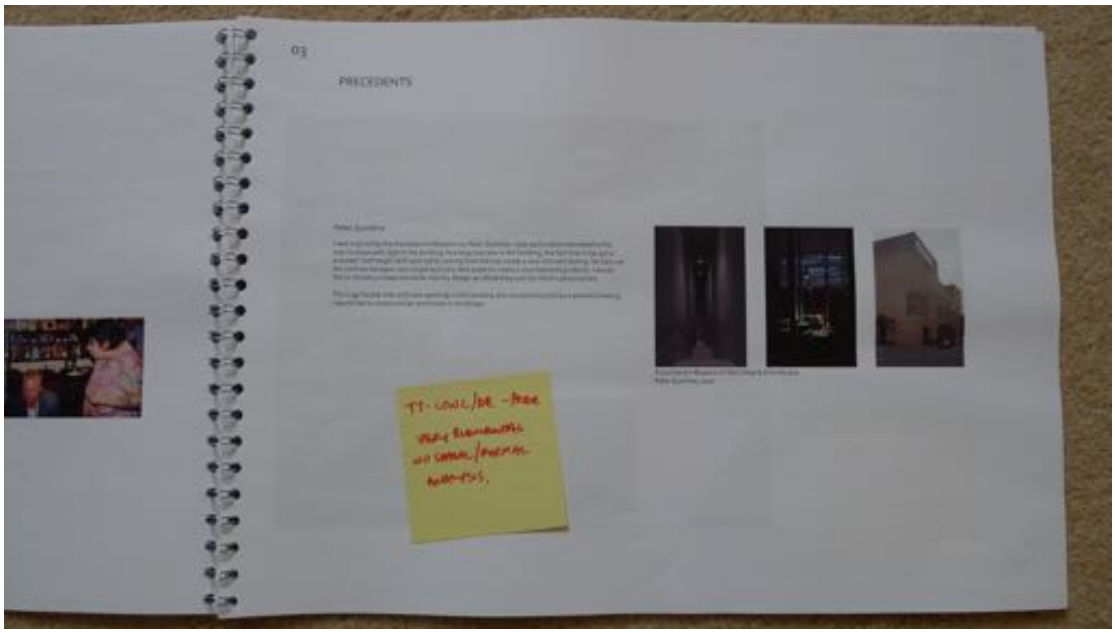


Figure D1: Phase 2 student A precedents

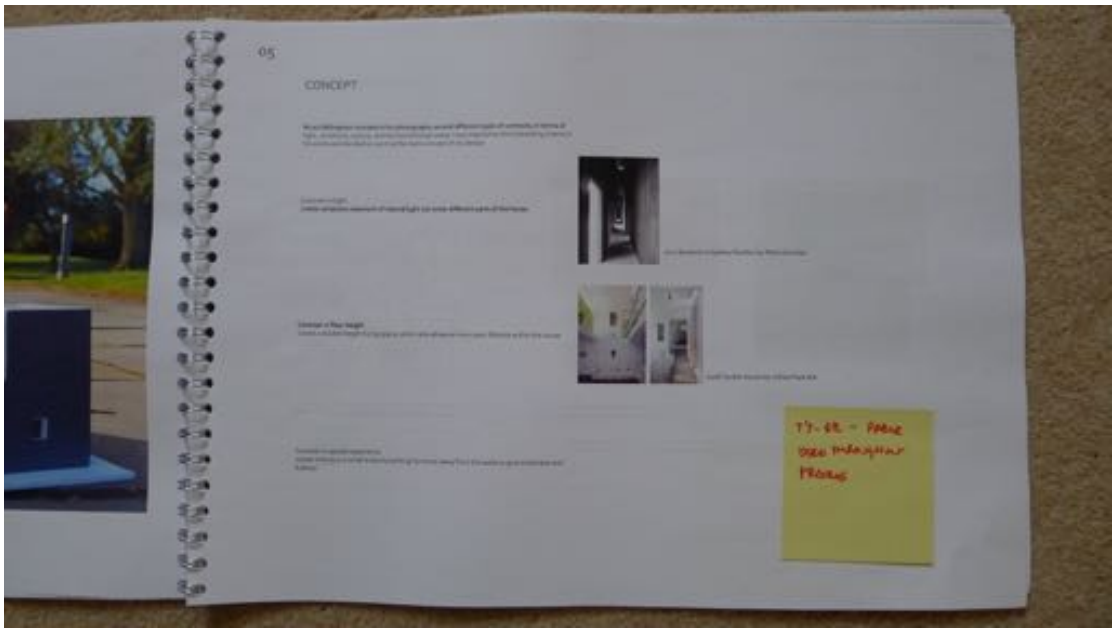


Figure D2: Phase 2 student A concepts

Figure D3: Phase 2 student A design development

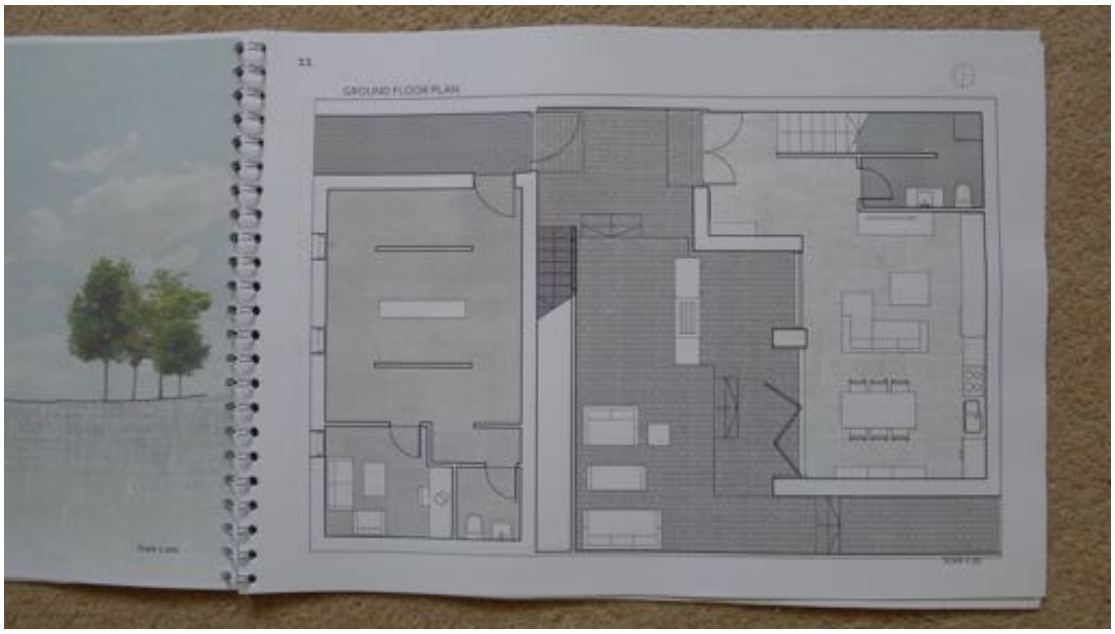


Figure D4: Phase 2 student A ground floor plan

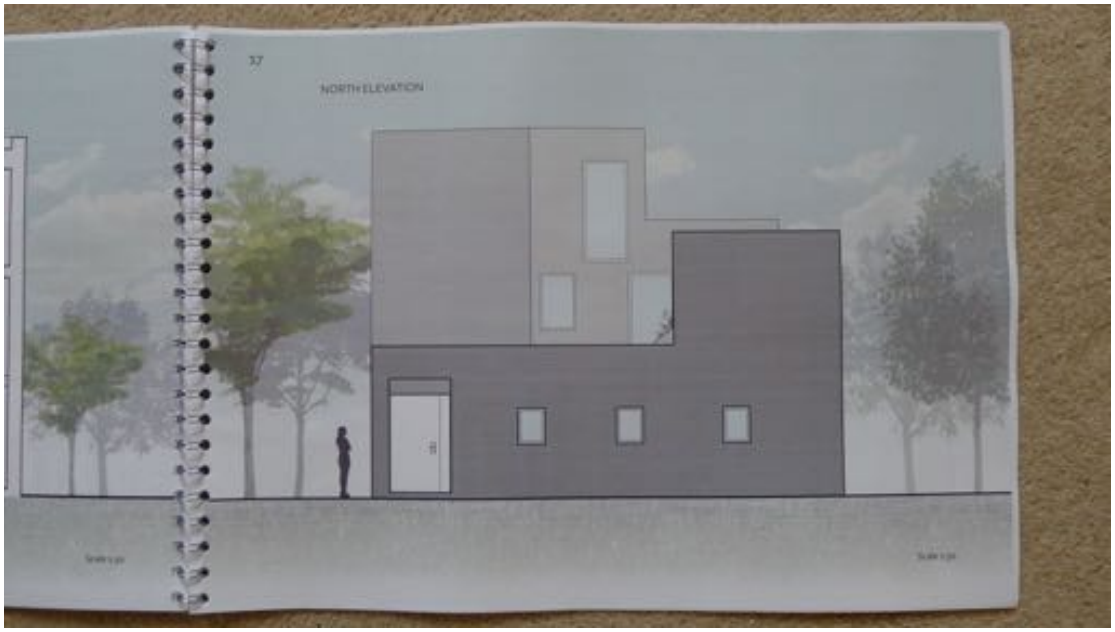


Figure D5: Phase 2 student A elevation

Figure D6: Phase 2 student B precedents

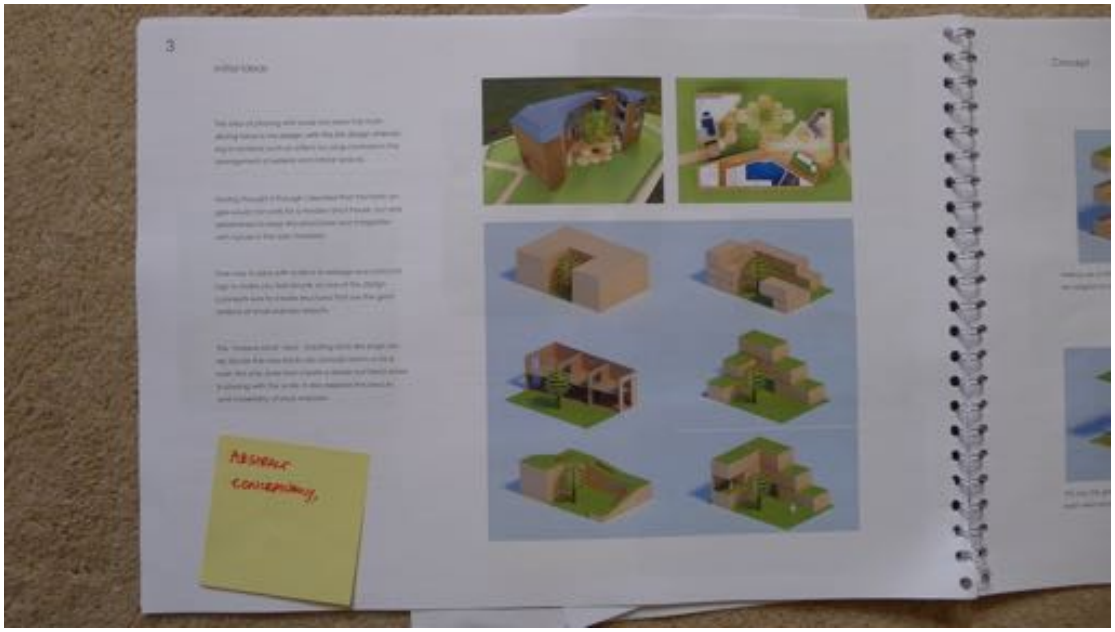


Figure D7: Phase 2 student B initial ideas

Figure D8: Phase 2 student B ground floor plan

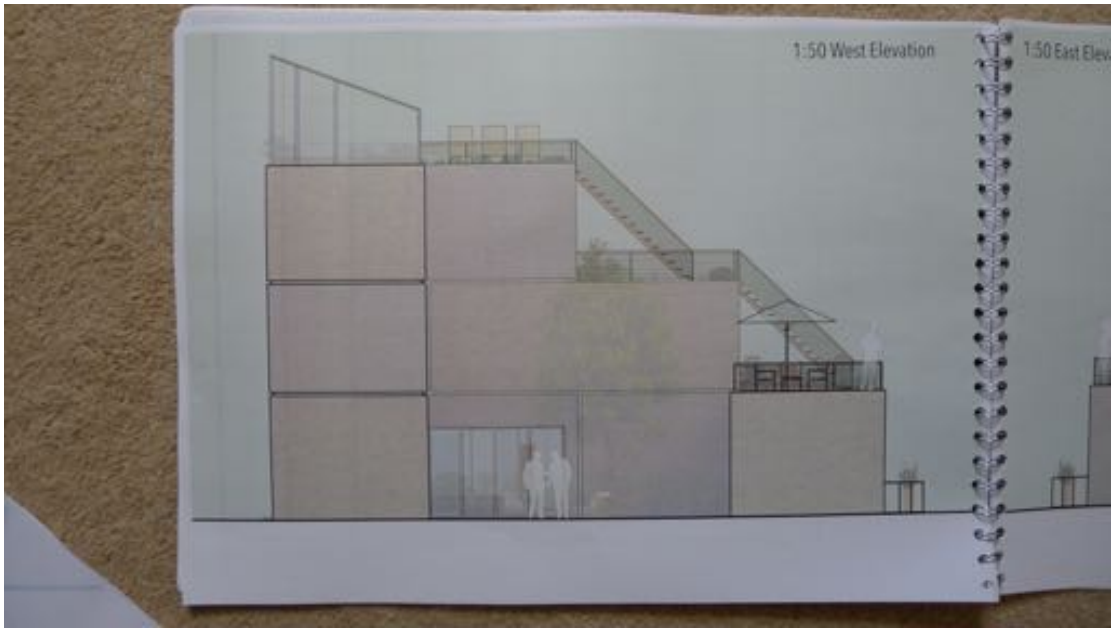


Figure D9: Phase 2 student B elevations

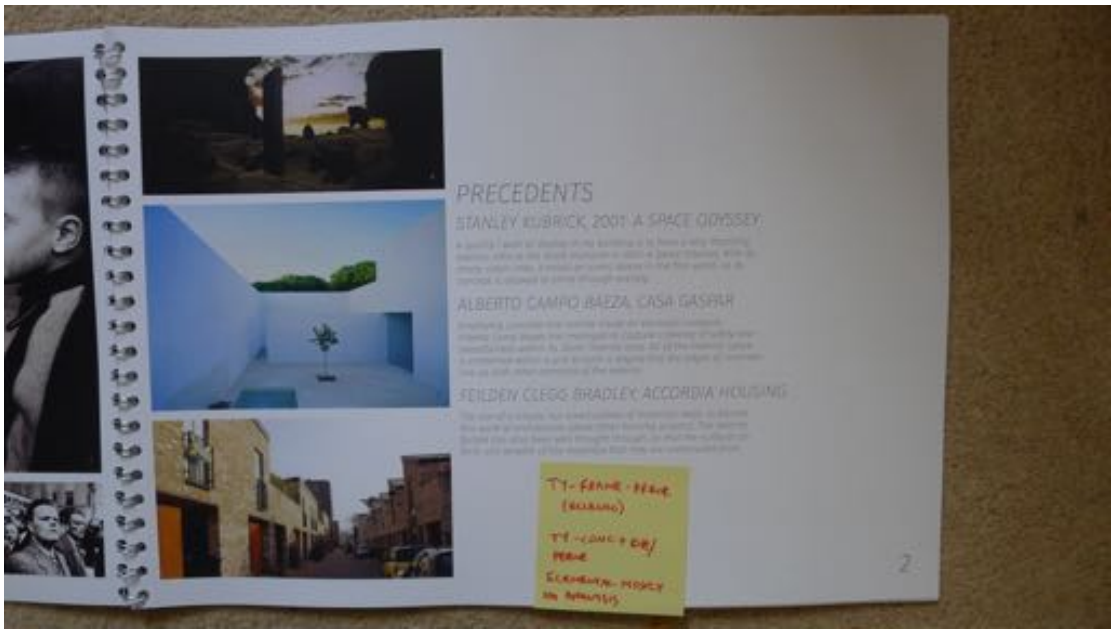


Figure D10: Phase 2 student C precedents

Figure D11: Phase 2 student C ground floor plan

Figure D12: Phase 2 student C elevation

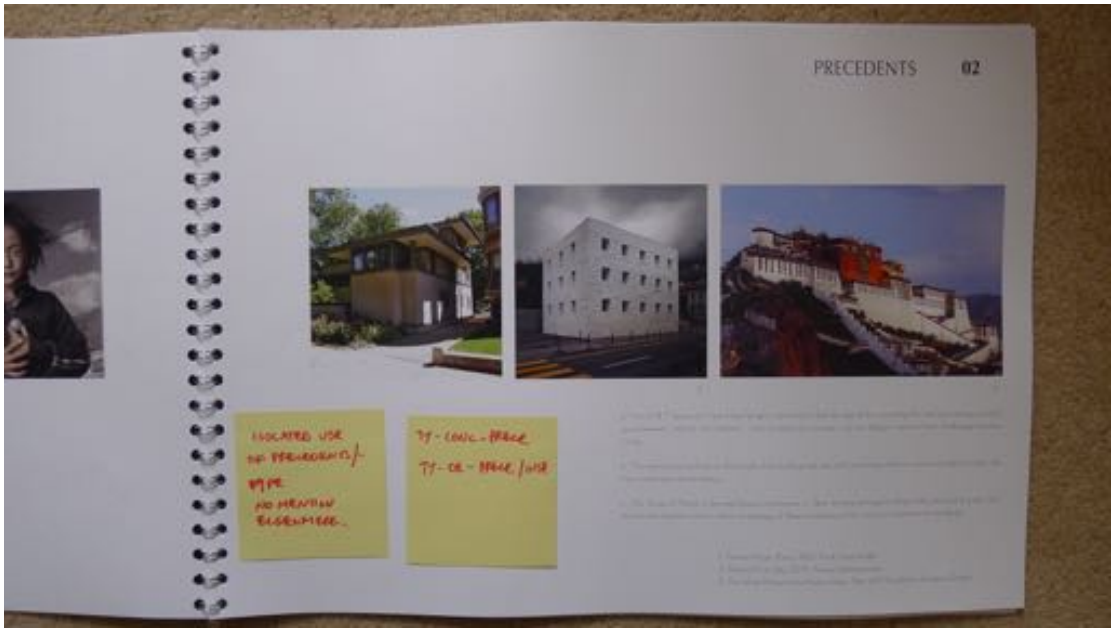


Figure D13: Phase 2 student D precedents

Figure D14: Phase 2 student D ground floor plan

Figure D15: Phase 2 student D elevation

Figure D16: Phase 2 student E design development

Figure D17: Phase 2 student E design development

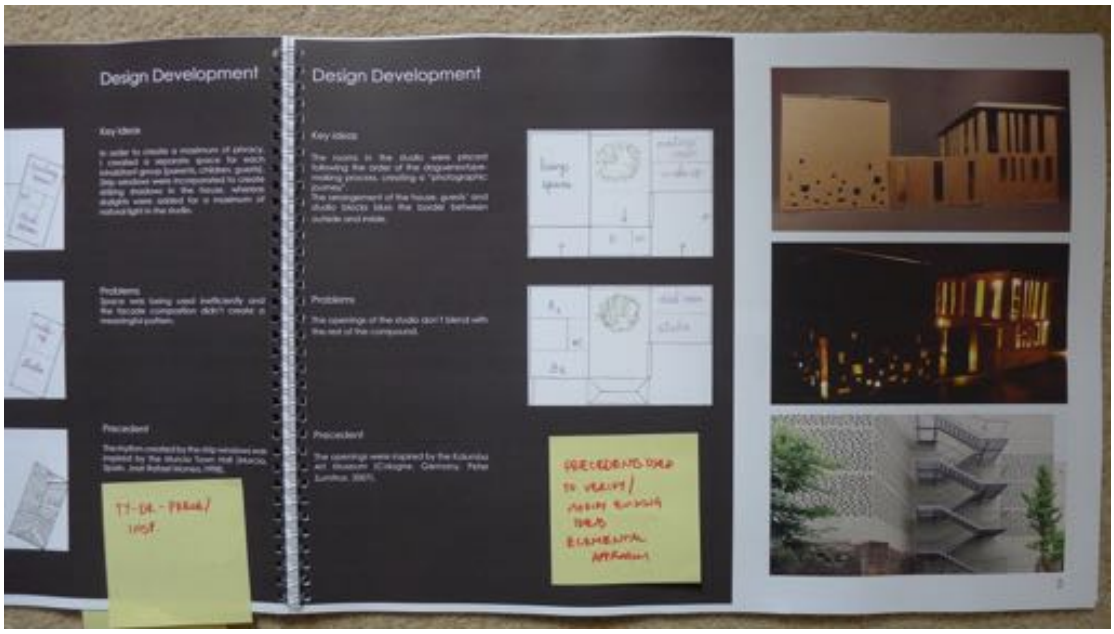


Figure D18: Phase 2 student E design development

Figure D19: Phase 2 student E ground floor plan

Figure D20: Phase 2 student E elevation

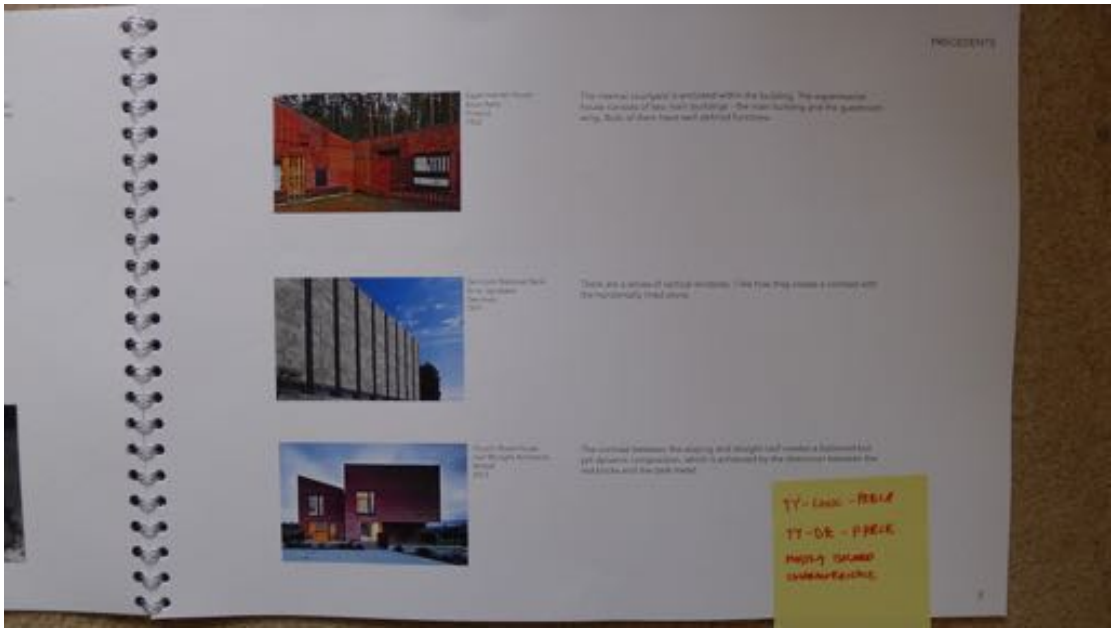


Figure D21: Phase 2 student F precedents

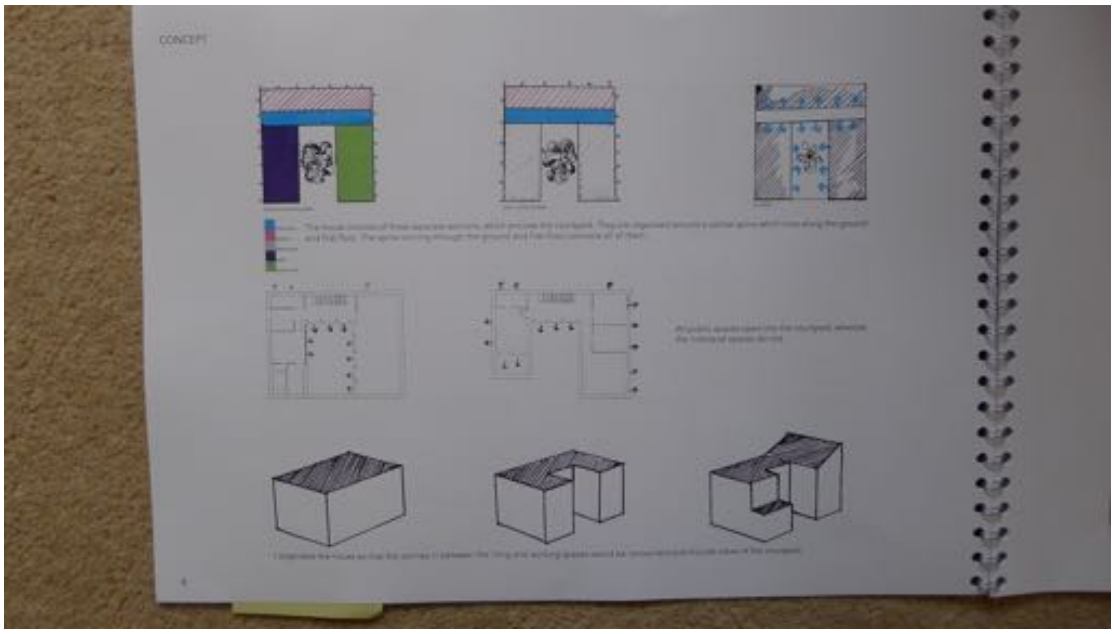


Figure D22: Phase 2 student F spatial concept

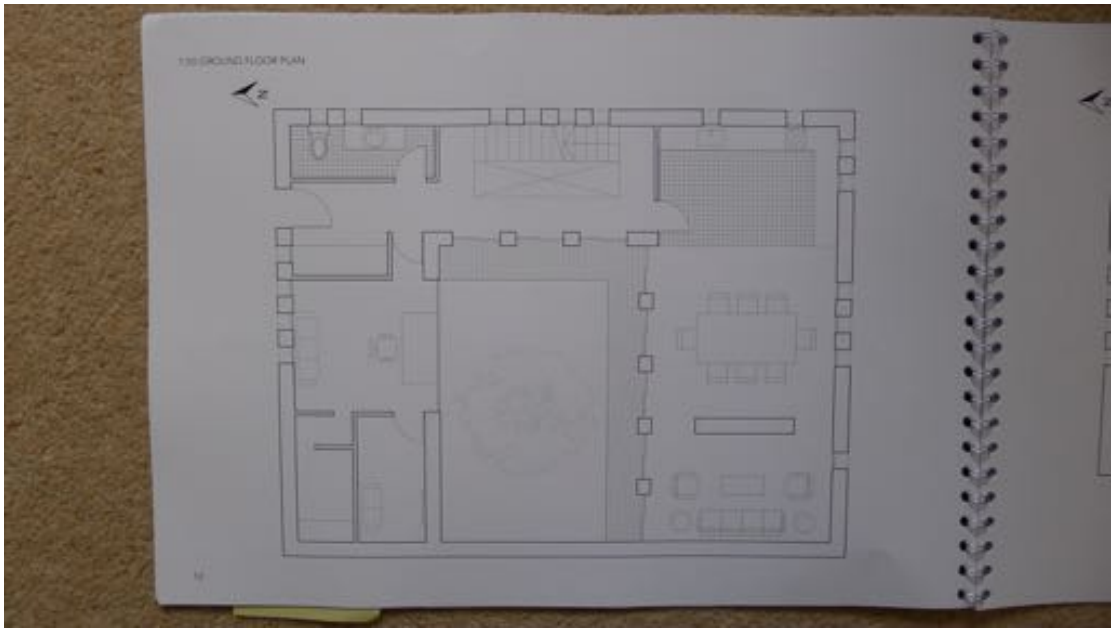


Figure D23: Phase 2 student F ground floor plan

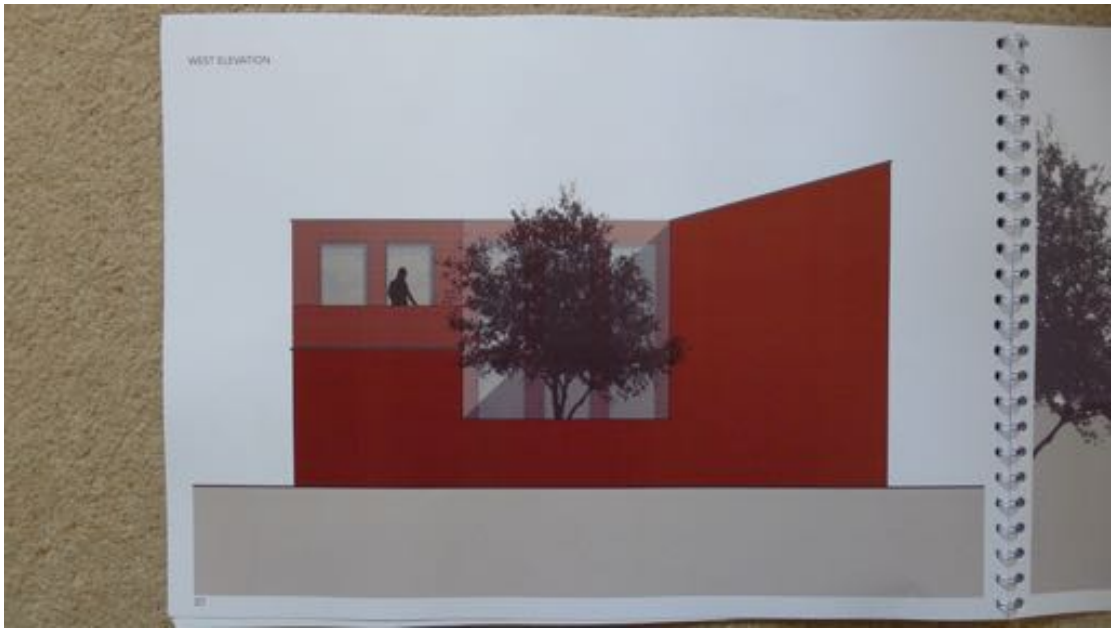


Figure D24: Phase 2 student F elevation

Figure D25: Phase 2 student G metaphorical typologies

Figure D26: Phase 2 student G metaphorical typologies

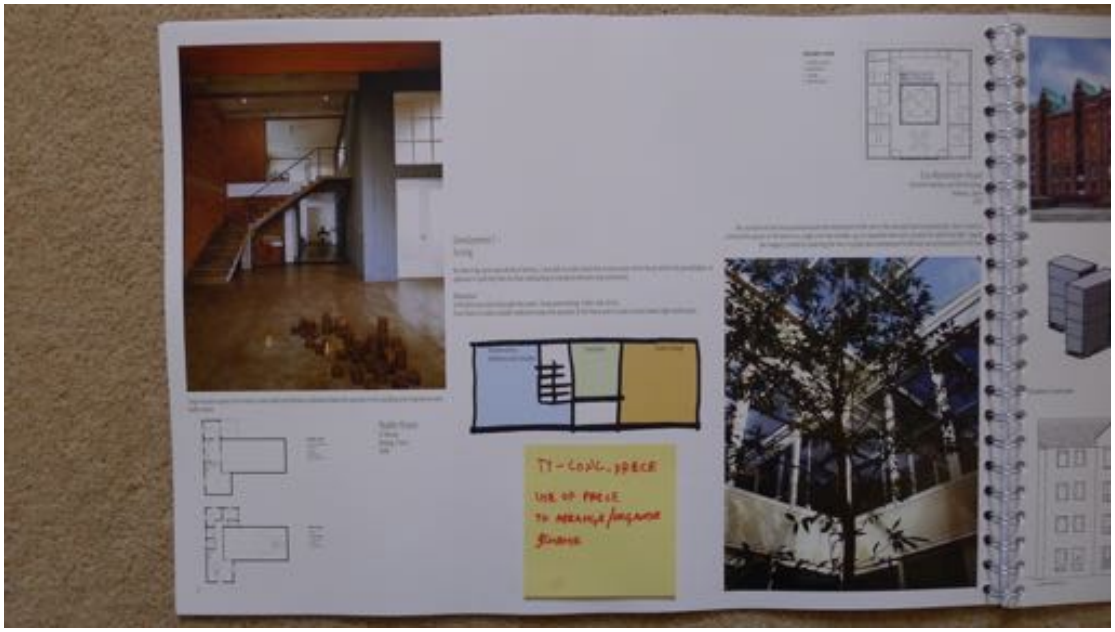


Figure D27: Phase 2 student G spatial typologies

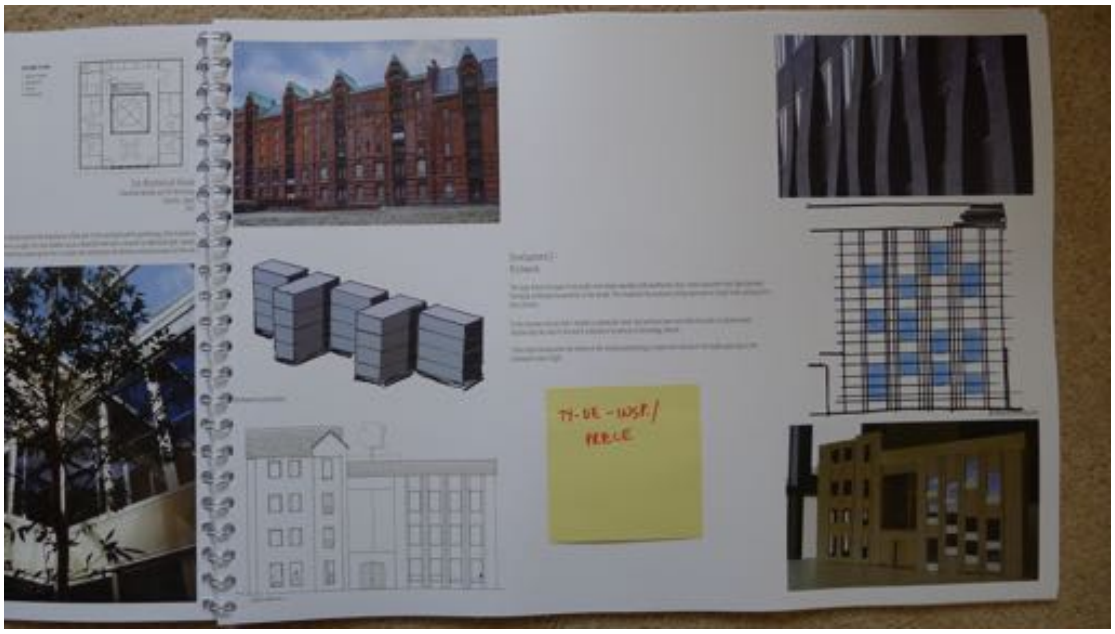


Figure D28: Phase 2 student G elemental typologies

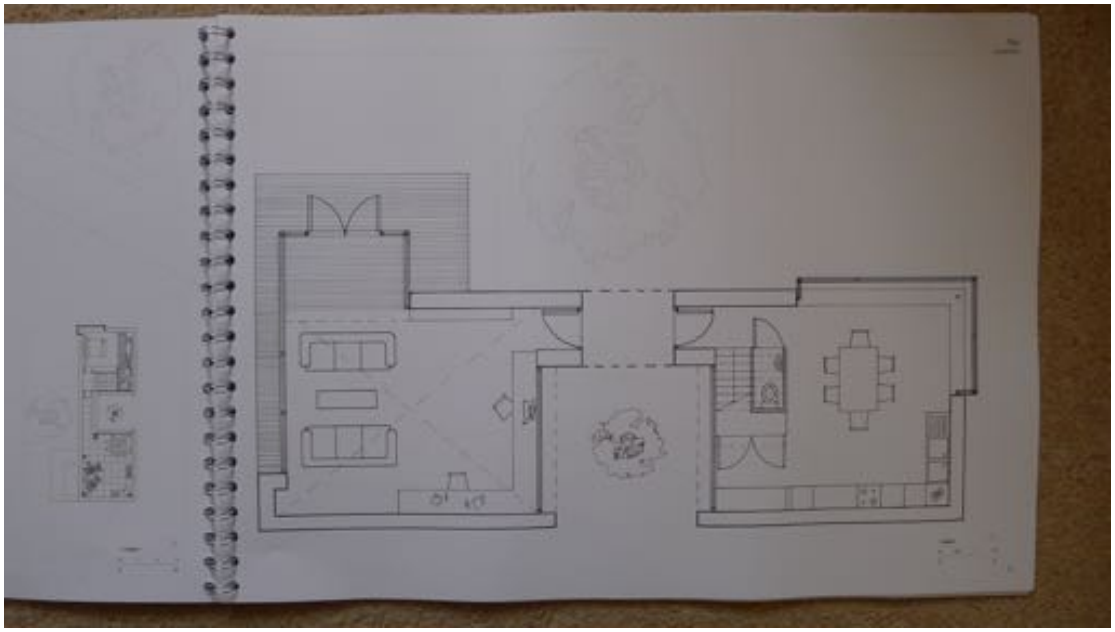


Figure D29: Phase 2 student G ground floor plan

Figure D30: Phase 2 student G elevation

Figure D31: Phase 2 student H precedents

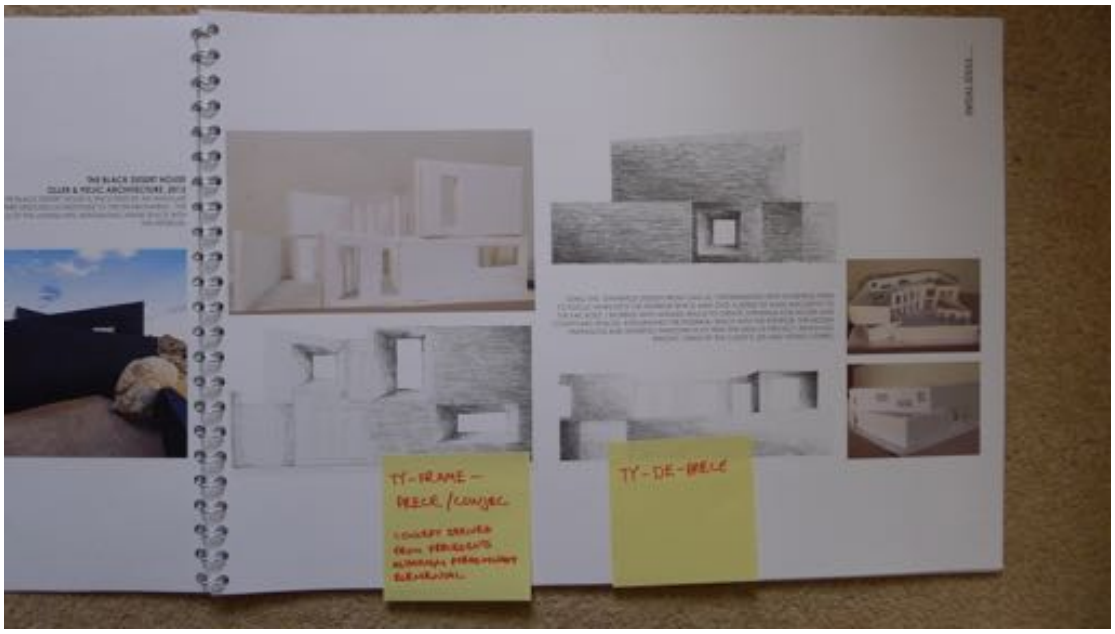


Figure D32: Phase 2 student H elemental typologies

Figure D33: Phase 2 student H ground floor plan

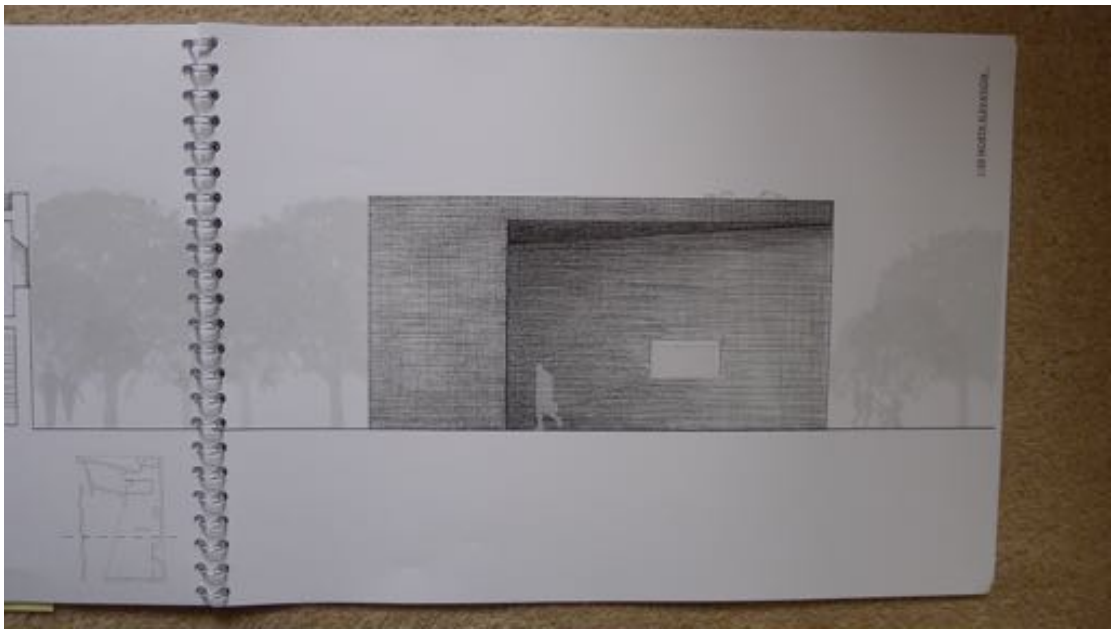


Figure D34: Phase 2 student H elevation

APPENDIX E: Phase 2 Structured Interview

	Which of the four workshops did you find the most useful in the design process?
G	The second workshop on precedents and spatial diagrams as it was good to learn how to zone a building which I felt was the essence of design. [TY-CONC-REL/POS]
C	The first workshop on categorising buildings as breaking down precedents into manageable chunks made them easier to understand. [TY-FR-UND/PREC/POS]. The second one, presenting spatial types, also helped understand the precedents. [TY-CONC-PRECE/POS/UND]
D	The one on diagrams (second workshop) as it was a straightforward way to understand buildings and a different way about thinking of architecture that I hadn't thought of. I was able to understand my scheme in a different way. [TY-CONC-IND/POS/UND]
E	It was useful to know how to draw diagrams of buildings as it makes you think and put into practice. You need to have a diagram in mind when you design and this is something that is useful but not taught. [TY-CONC-POS/UND/PRO]
H	The one on openings. I didn't realize there were different ways of making opening in my building and it helped because I had no clear strategy. [n.b. Missed spatial workshop] [TY-DE-RESOLV/UND]
F	The diagrams of spaces as it gave a sense of how to study precedents and use other buildings. [TY-CONC-PRECE/UND]
B	The first two workshops as they helped to form ideas and set specific categories. [TY-CONC/FRAME-INSP/TYPE]
A	The spatial one (2nd workshop) as it was best at that stage and made us think how the building would work. [TY-CONC-IND/UND]

	Would you change the order or timing of the sessions?
G	It would be good to have some of the sessions before starting. [FR-TIME-EARL-ALL]
C	The workshop on facades could have been earlier as it was helpful to locate specific precedents and most of my façade had already been done. [FR-TIME-EARL-DE] [TY-DE-PRECE]
D	The workshop on windows and facades should have been earlier as the façade affects the style of the building in different ways. [FR-TIME-EARL-DE]
E	The order of the sessions was good. [FR-STRUCT-POS]. The last sessions were to close to the deadline to fit into the design. [FR-TIME-EARL-DE] It was good having attempted a scheme already when approaching the workshops [TY-CONC-ANALY]. The first workshop was the least helpful as it was not in depth enough and they are thing that I would consider on my own. [TY-FRAME-NEG].
H	The workshops on elevations could have been earlier as I had already completed much of my design. [FR-TIME-EARL-DE]
F	The order of the sessions was fine. [FR-STRUCT-POS]. The one on openings could be moved earlier as I had already formed ideas. [FR-TIME-EARL-DE]
B	More about construction details and technical knowledge relating to the project. It would be useful to discuss more about this so we didn't design things that wouldn't work. [TY-DE- POS-TECH].
A	The last one with the openings could be before the scheme was finalized. [TY-DE-EARL] [FR-TIME-DET/EARL]

	Each had a different format (group work, individual work, presentation). Which did you find the most helpful in the design process?
G	The presentations (the final two workshops) as they gave clear inspiration which was hard to find on my own when hunting for precedents. [TY-DE-INSP] [TE-METH-PRESENT/POS]
C	Earlier on the more involved and interactive workshops were helpful however the presentations later on were good for dealing with specific problems. [FR-STRAT-POS] [TE-METH-FORM/POS]
D	The presentations were most useful as they introduced us to knowledge rather than having to find it ourselves which can be hard when we don't know what we are looking for. [TE-PRES-POS/RES]
E	It was good working as a group and making precedents specific to what we are doing. [TE-METH-GROUP/POS]. It was good having precedents near the start to get inspiration from. [FR-TIME-PRECE/EARL]. Presentations could have name and architect and perhaps a database could have been formed to help. [TE-METH-PRES-RES/DATABASE]
H	I remember the presentations, seeing the different images of precedents. I'm definitiely a visual learner. [TE-PRES-POS/RES]
F	The sessions which focused on my own scheme and were more individual. [TY-CONC-POS/IND] [TE-METH-IND]
B	The range of sessions was right for each stage of the design. [FR STRUCT-POS] [TE-METH-POS]. It would have been good to have more feedback in the later sessions from tutees. [TE-METH-GROUP].
A	The presentation as it actually taught me something and helped me analyse my design. [TE-METH-PRES/ANALY]

	Where did you feel precedents were most useful in your design process (creating a concept, details, spatial arrangement, materials etc)?
G	Defining the spatial idea [TY-CONC-SPATIAL/POS]
C	All the way through I had some strong conceptual, abstract ideas which I used such as *2001: A Space Odyssey* [TY-FR-ABSTRACT]. Later in the design process I referred to specific buildings for details and picked and chose elements rather than looking at broad categories of types. [TY-DE-PRECE/POS] [TY-DE/CONC-TYPE/NEG]
D	The one on initial ideas and spatial layout. [TY-CONC-SPATIAL/POS]
E	The spatial arrangement workshop was most useful. . [TY-CONC-SPATIAL/POS] The bref at th beginning is quite scary and it was good to consider precedents from the start. [TY-FR-PRECE/POS]
H	All the way through. It was good to have something to revert back to so I could go back to the original idea to help my design. [FR-STRUCT- POS]
F	How the house should be design informed by the earlier tutorials. [TY-CONC/FRAME-POS]
B	In defining the original concept – without that I would be designing a random house. [TY-FRAME-PRECE]
A	Developing the details and different elements of the scheme and the lighting. [TY-DE-POS]

Table E1: Phase 2 structured interviews

APPENDIX F: Phase 2 Checklist Matrix

Objective 1

To test and develop a framework for independent typology formation in the design studio

	Instructor Observation	**Participant Response**
Overall strategy, order and structure	Mirroring of design process in movement model typologies to detail typologies. Appeared to approximate the stage students were at in the project. Pre-design workshops exhibited less uptake into later schemes. Novice designers found it hard to link abstract ideas with typologies. It provided guidelines of how they should plan their work. Greater level of engagement observed in second workshop when conceptual designs were attempted (type was used as an analytical tool)	The overall order and structure of the workshops was deemed to be positive Generally all workshops could have occurred earlier Some preference for being presented with precedents which could have happened in a pre-design phase *"The range of sessions was right for each stage of the design"*
Timing of workshops	Pre-design workshop seemed successful in generating group cohesion, setting the typological agenda and encouraging quick decision making. Work shops too late in the process lacked engagement and stuents were reluctant to make changes.	Workshops occurring too close to the end of the project (2 weeks from deadline) were deemed too late to integrate into design by nearly all candidates *"The last sessions were to close to the deadline to fit into the design"* *"We only have 1 week – we can't really make changes now"*
Relevance	As the project space gained definition as did the structure of the workshops and they became increasingly more relevant to the project work. This direct relevancy however lacked learner defined typologies and so	Spatial workshop proved the most popular in terms of relevance providing a mix between skills acquisition, information gathering and individual relevance to shcemes. *"The second workshop on precedents and spatial diagrams as it was good to learn how to zone a building which I felt was the essence of design."*

Table F1 : Checklist matrix for objective 1

Objective 2

To examine pedagogic techniques for the inclusion of typology into design studio processes

	Instructor Observation	**Participant Response**
Workshop format	Getting individual responses was valuable in revealing inconsistencies in designs Group sessions favoured more vocal, stronger students. Quieter students had to be prompter.	Some students struggled with self group defined workshops (1 and 2) and some found it irrelevant. *"The first workshop was the least helpful as it was not in depth enough and they are thing that I would consider on my own"* These sessions worked well with those confident who were able quickly grasp the session but confused weaker students. *"Not sure how finding the different typologies/subcategories helped"*
Method of teaching/delivery	The tutor as facilitator was often a challenging role as the relationship between the tutor and student seemed to be considered to be one of imparting knowledge rather than discovering. Evidenced by student preference for presentations as the most valuable form of delivery. In instructional sessions students still were less able to form their own typologies when asked (often a hybrid) despite lack of group activity.	Most students identified the purpose of instructional sessions was to encourage consideration rather than a right and wrong approach. Presentations were preferred over finding own examples, partly due to the quality of material offered and the clarity of focus but also the feeling that the students were being taught knowledge. *"The presentation [was most useful] as it actually taught me something and helped me analyse my design."*
Practical concerns	Time to produce sessions for instructor. Gauging timing of sessions challenging. Production and distribution of materials. Inherent subjectivities of precedent choice and guidance formation could have limited student scope. Often trouble making clear purpose of session.	Access to and quality of precedents information produced was of primary importance in all sessions. This was noted in both sessions involve printed material and presented material. Participants preferred high quality images and a vast range of material from drawings to imagery. *"The images of precedents are not in colour which was difficult to look at"* Students sometimes complained of not being able to see

		presentations. *"Have people pass round precedents so I can see more in a shorter time"*
Engagement	In presentation, question and answer sessions, students were forced to engage and could not hide in group Development of the group occurred In presentations, however short, student disengagement was noticeable. (boredom!)	Students preferred to engage with workshops directly about their project. Diagramming own schemes was particularly valuable. In the initial phases, learning to pinpoint ideas and focus ideas was important.
Timing	Workshops, 3 and 4, which were more didactic in delivery, worked well as very short snappy sessions. Students appear to get bored over longer sessions and group activities were helpful. Very low uptake of late stage workshops. Some consideration but general lack of interest.	Some participants felt the rapid tasks encouraged quick decision making and creativity whilst a minorit suggested that some sessions felt too rushed. More flexibility in the active sessions would have helped balance student abilities. Workshops late in the design process were considered less successful as designs were 'finalised'.
Techniques	Of the techniques tested (presentations diagraming, categorizing as a group, discussion, lecturing, flooding with material) students aooeared to respond best to diagramming both their schemes and precedents. This made the work directly relevant to them.	There was a preference for straightforward delivery/presentation style due to clarity and active techniques were often considered unclear. *"The presentations were most useful as they introduced us to knowledge rather than having to find it ourselves which can be hard when we don't know what we are looking for."* Some students would have liked interaction post-presentation: *"It would have been good to have more feedback in the later sessions from tutees."* Learner lead sessions lacked definition for some learners however encouraged engagement and interaction. Diagraming proved a popular

		method to analyse own work and relate them to precedents. *"It was useful to know how to draw diagrams of buildings as it makes you think and put into practice. You need to have a diagram in mind when you design and this is something that is useful but not taught"*	

Table F2 : Checklist matrix for objective 2

Objective 3

To assess the effect of different notions of typology throughout the design process

	Instructor Observation	**Participant Response**	**Design Output**
Frame definition	Extracting architecturally relevant characteristics challenging for most students. Few were able to make connection between abstract ideas and actual typologies. Might be unhelpful to present precedents at this stage and only consider typologies and how they may link to buildings. Presentation of precedents appears to lead to a purely elemental understanding rather than forming models. Interpretation of written brief acted as a barrier to finding typologies. There was concern over having the correct brief and complexity lead to tendency to fall back on determinism. (call for simpler briefs or more student definition?) Following week's designs showed little relevance to	Little emphasis on how precedents or defined typologies might inform future work although this was the majority of the session. Looking through a consideration of precedents was particularly successful as it offered multiple ideas although most students felt the need to make decisions and pinpoint ideas, Most considered early stages about understanding/clarifying and defining the brief through practical/client considerations rather than typologically with little reference to types. *"Learnt how to pinpoint the values of my building which will be important to the design and how they correspond to the user"* Importance of problem framing understood. *"To analyse the task*	Very little evidence of defining frame in a typological way in the reports. Mostly this was done through abstract or deterministic mechanisms. EXAMPLES Occasionally initial ideas (conjectures) were supported or corroborated by precedents rather than typologies. Only one student defined their problem in typological terms, most reverted to abstract means although some heavily used precedents for 'inspiration'. Individual defined model typologies is a challenge for novice designers.

	workshops. More introduction or perhaps a presentation of types might have helped? Linking abstract, non-physical ideas to built precedents challenging. This might be more successful once initial design has been presented.	*thoroughly and thereafter to lay a strong base of the further design."* Breaking down the brief into simple stages (what does this refer to? Define client, define idea etc) Exercise was far more helpful in hindsight suggesting students were more engaged with it once they had already begun to design suggesting it is more analytical in use Variation between students who were confused by too many precedents and those who felt it was unhelpful.	
Concept Design	Students were in most cases were able to produce simple diagrams which they were able to identify as a type (based on earlier group analysis of precedents) Taught process of analysis seemed to encourage response Some students struggled to create simple diagrams and reverting to literal drawings of the plan (unable to see types in own work). Describing the process of reduction and showing examples helped. The diagramming of precedents and their own scheme created a level of analysis beyond an elemental one and formed inherent structured plans	Students felt creating diagrams of their schemes in this way they could reduce them to more understandable units. *"It allowed us to think about plans in a simple way"* Very few felt they were relating their projects to either precedents or types despite organizing into types. For many, the diagramming and arrangement of precedents into diagrams was almost a practice for thei own scheme rather than a means to relate to precedent. Helped students select precedents as they were able to know what to look for.	Evidence suggests an elemental approach was adopted throughout the design process where rather than define precedents into types and draw general principles, specific elements of individual precedents were used in an inductive manner. No examples of anaylsis of projects shown although some diagramming of own schemes. Some formal typologies recognized but generally through specific examples.

	Is producing a diagram in essence a typological act?		
Detail Design	At this stage instructional strategies seemed to work well. In most cases a finite number of types could be predefined by the instructor. Elemental approach meant all students could identify with these and instantly spotted flaws in their design. More easily understood ad incorporated than more abstract concepts All students identified common outcomes of the session to find clarity in opening/façade and detail strategies Again this appeared to work better as an analytical tool – few students took on new typologies but focused on an existing type to add clarity.	Clarity in presentation, delivery and focused was valued highly. Students again valued quality and quantity of precedents. Even reluctant students to adapt designs were encouraged to by presentation. Even when simple details, as yet undefined, students would not make changes if presented too late in the project. General concensus that this should take place earlier in the design process.	Generally there still seems a predominantly elemental approach to the project *"The windows are aligned in column which is a typology of Tibetan architecture that I want to include in my design"*

Table F3 : Checklist matrix for objective 3

Changes and recommendations:

	Problem	**Recommendations**
Overall	Access to precedents	Consider a student lead database of projects
	Practical viewing of precedents	Online media may offer opportunities (eg Pinterest etc)
	Challenging formation of types from precedents. Precedents generally viewed in isolation	Present types rather than specific instances. A more general introduction to the process/framework maybe more successful and allow students to find precedents themselves. Be more strategic in description.
	Type undermines originality	Focus on originality and 'creativity'
Frame Definition	Complexity of brief stood as barrier to creating architectural ideas and students feel onto deterministic methods and brief to determine	Simplification of brief or student lead briefs

	project frame.	
	Trying to form categorization of model types from scratch	Find precedents first then form types Present a number of models Use other techniques eg descriptions of space to form a personal model type
	Pre-design exercise only comes into use once students have started to design	
Concept Design	Gen	
Detail Design		

Table F4 : Changes and recommendations

APPENDIX G: Phase 2 Project Brief

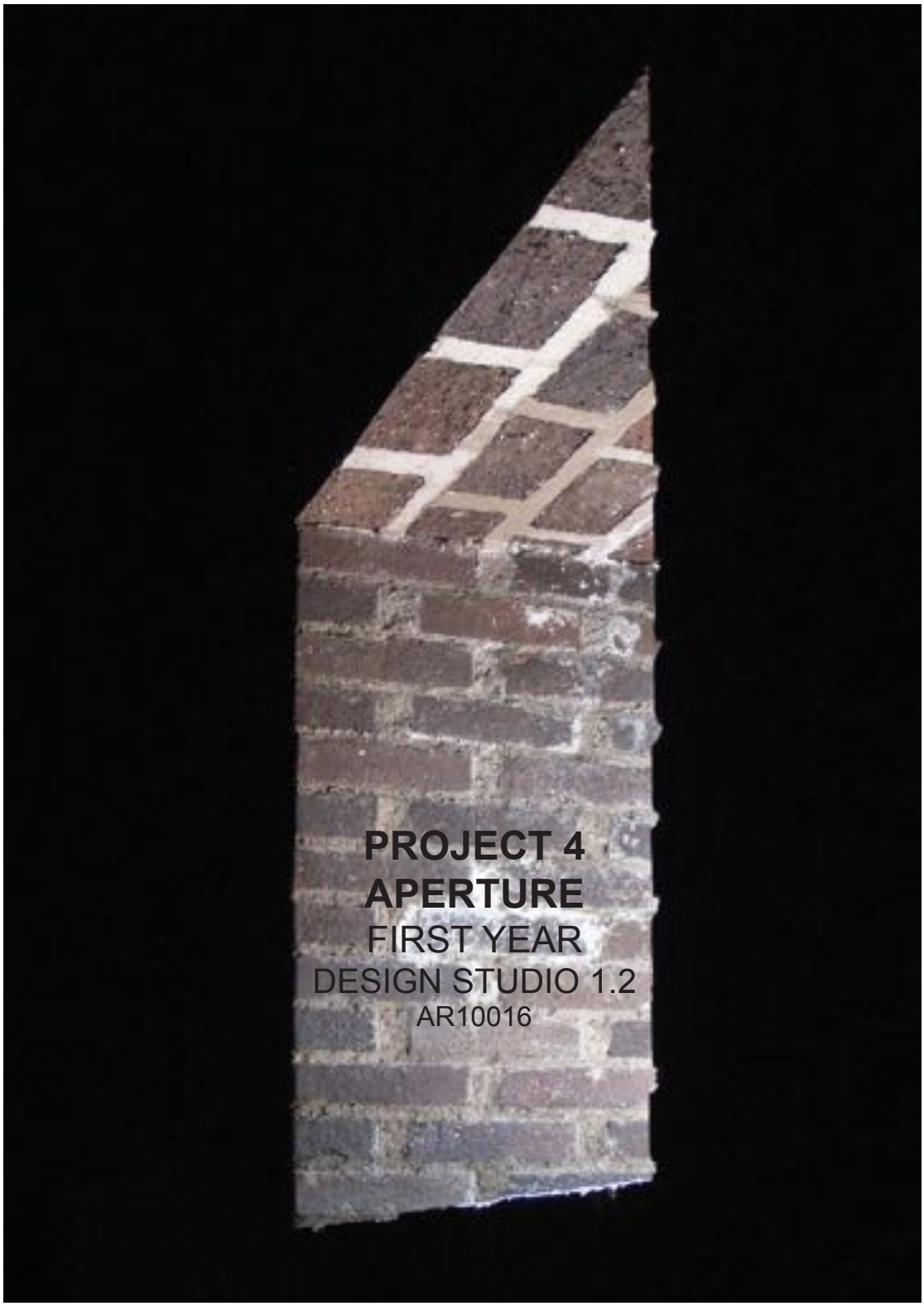
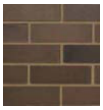
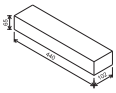
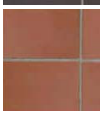
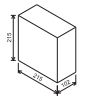
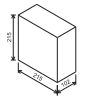
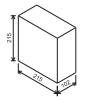


Figure G1: Phase 2 general project brief

		**BLUE**	Staffordshire Blue Brindle Dragface	**2221**	Wirecut Dragfaced
		**GREY**	Crowborough Multicoloured Stock	**4002**	Stock sandfaced
		**BROWN**	Cheddar Brown	**0612**	Wirecut Smooth
		**BUFF**	Funton Old Chelsea Yellow	**4053**	Stock sandfaced
		**RED**	Heritage Red Blend	**4986**	Stock sandfaced
		**LINEAR**	Birtley Olde English	**2602**	Waterstruck
		**LINEAR**	Birtley Olde English	**2602**	Waterstruck
		**LINEAR**	Birtley Olde English	**2602**	Waterstruck
		**FIREBORN**	Black	**BF0321**	Wirecut Extruded
		**FIREBORN**	Natural Red	**BF0360**	Wirecut Extruded
		**FIREBORN**	Natural Cream	**BF0362**	Wirecut Extruded
		**FIREBORN**	Black	**BB0321**	Wirecut Extruded
		**FIREBORN**	Natural Red	**BB0360**	Wirecut Extruded
		**FIREBORN**	Natural Cream	**BB0362**	Wirecut Extruded

DESIGN STUDIO AR10016 - PROJECT 4 – APERTURE

> "Thinking of the great multitude of English houses, row upon row smoking into city sunsets or shyly clinging to the skirts of village elms, the mind reels. This is a private world. Behind the decent of the defiant street face, behind the lamp lit curtain, a personality as varied and subtle as the human character itself is hidden."[1]

Each project builds on what you have learnt in preceding projects:

In Project 1 – EQUILIBRIA, as part of a group comprising architects and engineers, you designed a free-standing structure based on the theme 'EQUILIBRIA', and experimented with various drawing and model-making techniques - many of you for the first time - and attempted to compose your work in a coherent, logical, as well as elegant manner.

In Part 2 of the project you built a full scale version of your design in the actual materials. This exercise showed how difficult it is to manipulate real materials, and how simplicity of design and detailing are difficult to achieve.

In Project 2 – OBJET TROUVE, you designed a relatively simple timber structure for a specific object(s). This involved formulating ideas about exactly what was necessary, both functionally and psychologically, and how people might use it. You also discovered that how a building is made, or constructed and detailed, is fundamental to the whole design.

In Project 3 – FRAME, you worked with your first outdoor site - there was weather to contend with(!) - on which you designed a pavilion using a combination of metals/plastics and glass. You saw that context; how, and where, a building sits in relation to its surroundings; and orientation are major aspects of the design process. These needed to be balanced with your ideas about both structure and materials.

All of these projects have demonstrated how difficult it is to transform good *ideas* into a tangible convincing *reality*.

This, **Project 4 – APERTURE** is the longest and most important project of the first year. We hope that in this exercise you will be able to bring together everything you have learnt from the projects so far. With practice we hope you can develop your skills further in design, drawing, and model making.

This is also the first project in which you will tackle multi-level planning. This calls for the design of a staircase(s), and careful consideration about where the 'services' – the bathroom/toilet blocks etc. are positioned within the plan.

> "To design and make ordinary things, but to invest the whole process with a love for the materials that they are made from, that is what we should learn. Then you can imbue the plain, the ordinary, with something magical."[2]

[1] Lionel Brett from *The Things We See - No.2: Houses* 1947 Penguin Books
[2] Stevens, D *Domestic* 2001 Mermaid Turbulence

INTRODUCTION

In this project we want you to examine the idea of a home around a courtyard. We have, no doubt, all seen examples of flats and houses in books and websites, such as Dezeen, which are full of the latest concepts ranging from the small and utilitarian, to more luxurious and generous dwellings. Although we want you to look *and learn* from such examples, we ask you the question, what should a new courtyard house environment provide – *what could houses actually be like in the 21st Century?*

> "What interests me is the opportunity for all of us to become something different from what we are, by constructing spaces that contribute something to the experience of who we are."[3]

As you may have discovered in the projects so far, without careful analysis of the problem at the beginning you will find it difficult to come up with a strong, coherent design concept.

We have all experienced some type of *dwelling* or home. In the UK this is usually a terraced or 'detached' house; in mainland Europe and Asia it is more likely to have been an apartment. Often there will be a separate 'living' room, kitchen, one or more bathrooms and several bedrooms. Some may even have had a garden. Is this an ideal type of dwelling to live in? What kind of house would help overcome some of the frustrations we have all experienced as well as enhance the positive aspects of a 'home'?

Should the house be one storey or two, built around a series of courtyards? Maybe the dwelling should all be in a tower with the various activities stacked? Should there be individual rooms at all? Is it preferable to have separate zones or 'wings' as part of the scheme? Should each occupant have their own detached 'house'? The issues of maintaining 'community' while also enabling individual privacy are paramount.

If you look at precedents, you will see that they are often divided up into a series of habitable spaces and 'courtyards'. In *The Modern Courtyard House* Duncan Macintosh states:

> "Privacy is the key quality of the courtyard house. It looks inward onto a private garden which is as enclosed and intimate as any room of the house. As the source of light, and the connection, with the weather and plants, the courtyard is the centre of the dwelling. It facilitates life out-of-doors because it is sheltered from the wind, free from being overlooked by neighbours and shut off from the noise of the public world. While in summer the courtyard becomes a second living room, in winter it remains the element which unites all the rooms which look into it."[4]

Along with housing design we want you to investigate ***masonry*** construction i.e. using 'baked clay' materials – brick or blocks. The key parameter is the piling up of smaller manageable sized pieces to create a whole which has both a visual and a literal 'weight'.

> "It is important that you honour the material you use. You don't bandy it about as though to say, "Well, we have a lot of material, we can do it one way, we can do it another way." It's not true. You must honour and glorify the brick instead of short-changing it and giving it an inferior job to do in which it loses its character, as, for example, when you use it as an infill material, which I have done and you have done You can have the same conversation with concrete, with papier-mâché, or with plastic, or marble, or any material. The beauty of what you create comes if you honour the material for what it really is."[5]

[3] Richard Serra from *Torqued Ellipses 1997 Dia Center for the Arts*
[4] Duncan Macintosh from *The Modern Courtyard House* 1973 Lund Humphries
[5] Louis Kahn from *Between Silence And Light,* John Lobell, 1979, Shambala Publications

THE BRIEF

Ibstock, a UK based brick manufacturer, wishes to demonstrate the variety and versatility of its products. To do this it has asked several architects to design 'model' homes – you are one of them. At the final crit Ibstock will judge the designs and award prizes.

As Ibstock produce bricks, and other clay based products, the houses will be built using masonry construction. This is an integral part of the brief and should be borne in mind at all times. There is a limited palette of brick in 5 colours, 2 blocks each in 3 colours, and a linear brick in three lengths from which to choose – 14 in total.

The house should be designed for a couple, yet to have children, but there should be two additional 'bedrooms' – a 3-bed house. But you should think very carefully what these additional rooms might be used for if they weren't to become bedrooms.

Both partners work but one of them works from home. You must decide what the partner who works at home does for a living. This is where your research into photography will come into use. **You must create a world of work that revolves around photography, in its broadest sense, and then use this as the basis for your design – do not be too conservative in this aspect of the programme as it will prevent you fully realising the potential of the brief.** The single restriction on your choice of work is that it can't be spent mostly at a computer, sitting down. It should be physically involved and not 'desk-based'.

The Gross Internal floor Area (GIA) of the house, both live and work elements, should not exceed 200m^2.

The schemes are all to be designed to appeal to people who wish to live in a modern house which encapsulates a certain type of 21st Century living – this does not mean a technology/gadget centred existence but rather an ideal to strive towards a simpler life devoid of the distractions of the modern age, but heightened by the quality of the materials at your disposal and the space you create.

> "The things that make a beautiful, lovely house are ordinary."[6]

You must accommodate at least the following in any configuration you deem appropriate:

- A place, or places, to prepare and eat food
- A place, or places, to wash and defecate
- A place, or places, for all occupants to sleep
- Accommodation for a guest couple, ideally with separate washing facilities
- **Any other accommodation you think desirable**

You do not have to provide space for a car within the footprint of the site.

You can use as much, or as little, of the site as you wish for the dwelling(s) as long as you stay within the boundary of the site but you must DESIGN ALL of the site. The thickness of your walls must be *within* the boundary line. You should assume an external wall thickness of 400mm as the sponsors would like to demonstrate that the house of the future will be a heavily insulated building which uses mass to mitigate the need for plastic based insulation or air-conditioning.

> "There are writers who spend their lives writing the same book over and over again. There are writers who think their books are autobiographical. There are architects who spend their lives designing the same house over and over again. There are architects who spend their lives waiting for the same client: him-self. For fourteen years, ever since my first project, I have gone on designing the same house as if obsessed. Though all these houses are the same, they are different, because the people and the places deserved it."[7]

[6] Stevens, D *Domestic* 2001 Mermaid Turbulence
[7] Eduardo Souto de Moura from *Eduardo Souto de Moura*, Esposito, A & Leoni, G 2003 Electa

THE SITE

The sites for the houses have been masterplanned to consist of a 3 x 2 grid of 6m x 6m squares. One square of each grid contains a tree and cannot be built on. Of the remaining 5 squares only an equivalent of up to 4 can be built on to accommodate the live-work home. The remaining square(s) and the tree square should be carefully designed as integral 'outdoor rooms' as part of the scheme.

There are views to the south over a landscaped park. However, the passage between plots is a public footpath leading into the park. So providing privacy at ground floor level is important.

ALL building must be WITHIN the 12m x 18m site plan. No basements can be built. There is no height limit. A roof overhang of 300mm is permitted if a pitched roof with overhang is used.

ISSUES

You should carefully consider the size and nature of each area based on how you think it will, or should, be used. Particularly important aspects, of the building are:

1. Access – Are there different entrances for the house – 'back' door and 'front' door? Do guests have their own entrance?

2. Orientation - Should certain functions be placed in a certain part of the house because of the plot's orientation? Which part of the house is used in the morning? Which in the afternoon?

3. Privacy – How much privacy do the owners need? If there's a work space does it need to be separate? Does the guest space need more privacy? What about sound travel?

4. Storage – The key to an apparently simple 'minimal' living space is plenty of storage. Where should it be? Can storage be used to aid acoustic separation?

5. Circulation – Is the house 'zoned'? Is there a zone for circulation – stairs and corridors – and inhabitation? Are there several staircases? Are they prominent or hidden?

6. Daylighting – North light is appropriate for some tasks and South light is better for others. How is daylight manipulated by your building to best effect?

7. External Space – Can you incorporate additional courtyards, roof gardens, terraces, balconies or any other external space within your scheme? What level do they occur at? Ground, 1st, 2nd, roof?

8. Fenestration – Your elevations will need designing for the function behind the façade but what's their response to context?

9. Materials – You must decide on a masonry choice, but you must also choose several other materials for your palette? Floors can be things other than wood, and walls can be things other than white painted plasterboard. What are they?

10. Services (Plumbing) – water, and waste, don't like running horizontally. Where are the WCs? What's on the floor below them? Do your 'services' line up? How does the water reach that bath tub in the middle of the bathroom?

> "The house does not have to tell anything to the exterior, instead all its richness must be manifest in the interior."[8]

[8] Adolf Loos dictum stated in 1914. Reference to *Raumplan versus Plan* Libre by Max Risselda (ed.)

DRAWINGS

Think carefully about what you show and how you show it, and make sure your work communicates not obfuscates. You will need to produce the following:

1. A large scale context plan – 1:200. This should show the roof plan of the house in relation to its surroundings, and other houses.

2. A large scale context section – 1:200. This should show the elevation of the house in relation to its surroundings.

3. 1:50 plans of each floor of the building. These must show the general arrangement of the spaces **inc. furniture, floor finishes - internal & external spaces.**

4. Three 1:50 cross-sections, two N-S and one W-E, through the building **including furniture.** These should also show the landscape spaces and planting.

5. Four 1:50 elevations - North, South, East and West of the building.

6. At least four views **at EYE LEVEL** – at least two internal.

7. A final model at 1:50 of your scheme - photographed well.

PROJECT DESIGN REPORT

For the crit you are to prepare a max. 30 side A3 report (excluding cover, contents and references – with only 'content' pages numbered), landscape format, spiral bound & acetate covers. No page should have more than 150 words of body text (excluding annotations) and the report should contain:

- **Cover with model photo, and your name in the bottom right hand corner**
- **One drawing set, as outlined above**
- **Rough sketches/Initial ideas/Design Development**
- **Precedent images, with all designers named and project dates and locations**
- **At least three photos of the model**

The general layout of the sheets is important – they must concisely explain your scheme in your absence. The report should express your design intentions, and be confident and elegant in execution.

FEEDBACK & MARKING

Please remember that tutorials and crits, as well as formal feedback sheets are ALL feedback on your work.

An individual Feedback Sheet for this project will be issued in Week 33. This is based on the ILOs in this brief. The feedback sheet will give an indication of any student the school feels may be in danger of failing design studio. This means these individuals *may* fail and it would be prudent to undertake additional work to bring some elements up to standard. Final marks are decided at the Portfolio Design Review and consequently you will have time to do work in response to any feedback received before the final unit deadline.

The final Studio deadline is Thursday 19th May (Week 34). By this point you will need to upload PDFs of the design reports (both whole updated and whole original as appropriate) for each Semester 2 project **AND** resubmit the printed versions (whole original and updated pages only as appropriate) to the 2E Faculty office with cover sheets including accurate descriptions.

TIMETABLE

(Week 24) Mon 7th Mar Introduction in 6E Crit Room 10:15-11:15
House Design Lecture by Graham Bizley 12:00-13:00 Crit Room

(Week 24) Thursday 10th Mar – design work continues
Basic scheme drawn and modelled at 1:50

(Week 24) Thursday 10th Mar – 'Monday' students' Field Trip - Meet 09:30 East Car Park

(Week 25) Monday 14th Mar – Thursday 17th Mar
Developed scheme, with another maquette, drawn (including furniture) all drawings at 1:50

(Weeks 26-27) EASTER VACATION

(Week 28) **Monday 4th Apr – Thursday 7th Apr – INTERIM CRITS in CRIT ROOM**
Interim Crit of ALL drawings (2 no. 1:200, min. 9 no. 1:50s = 11 dwgs min.)

(Week 29) Monday 11th Apr – Thursday 14th Apr (Model Making Tutorials Thur)
Finalise scheme design

(Week 30) Monday 18th Apr – Thursday 22nd Apr (Model Making Tutorials Mon & Thur)
GA drawings & final model

(Week 31) Monday 25th Apr (NO Tutorials) – Thursday 28th Apr - CRIT
Photograph model, Finalise Report by Wednesday 29th Apr <u>& BIND</u>

(Week 31) Thursday 28th Apr – FINAL CRIT IN THE CRIT ROOM & 6E 2.5, 2.6, 2.7
DESIGN REPORT HAND-IN 4.30PM CRIT ROOM

<u>Please don't forget that time is a design constraint. You have 6 weeks and 5 tutorials.</u>

INTENDED LEARNING OUTCOMES

1. An interpretation of the brief for a live-work house in the 21st Century to include a clear, logical, functional plan layout for a multi-level dwelling and integrated external space(s) that clearly expresses the nature of the materials in response to the brief.
2. A clear overall structural understanding and strategy for a masonry building.
3. To complete a well drawn set of drawings, all as listed in the brief that clearly show the building and context.
4. To produce a well crafted 1:50 model of the scheme that clearly shows the building and context. (Laser cutting is not permitted)
5. To present the work in a well designed A3 design report which does not use narrative text but instead employs diagrams and sketches with annotations, and has a model photo on the cover.

Notes:

An incomplete learning outcome will be marked zero.

In instances where the minimum pass mark of 40% is not achieved for any individually weighted learning outcome for a project the overall aggregate mark for the project will be capped at max.39%.

Failure of any learning outcome will result in the failure of the unit with a capped mark of max.39%.

Unit marks are subject to moderation internally, and approval by the Board of Studies.

Matthew Wickens 2015-16

APPENDIX H: Phase 3 Data Analysis

		Test Group	Control Group		Study Group	Control Group
1. I prefer to design using only my own intuition	Stongly agree	0	3	Stongly agree	0%	14%
	Agree	1	7	Agree	14%	32%
	Not sure	1	4	Not sure	14%	18%
	Disagree	3	7	Disagree	43%	32%
	Stongly disag	2	1	Stongly disag	29%	5%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
2. I use examples of historical architecture as inspiration to help me design	Stongly agree	0	0	Stongly agree	0%	0%
	Agree	5	13	Agree	71%	59%
	Not sure	1	5	Not sure	14%	23%
	Disagree	1	3	Disagree	14%	14%
	Stongly disag	0	1	Stongly disag	0%	5%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
3. I feel the use of precedents restricts my creativity	Stongly agree	0	2	Stongly agree	0%	9%
	Agree	0	2	Agree	0%	9%
	Not sure	0	3	Not sure	0%	14%
	Disagree	5	13	Disagree	71%	59%
	Stongly disag	2	2	Stongly disag	29%	9%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
4. When I pick precedents for my work I choose them because they have a similar function to my brief	Stongly agree	0	3	Stongly agree	0%	14%
	Agree	4	10	Agree	57%	45%
	Not sure	0	7	Not sure	0%	32%
	Disagree	3	2	Disagree	43%	9%
	Stongly disag	0	0	Stongly disag	0%	0%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
5. I judge my own work against precedents to help work out when it is successful	Stongly agree	1	1	Stongly agree	14%	5%
	Agree	3	10	Agree	43%	45%
	Not sure	1	6	Not sure	14%	27%
	Disagree	1	4	Disagree	14%	18%
	Stongly disag	1	1	Stongly disag	14%	5%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
6. I feel historic buildings are relevant to modern design and architecture	Stongly agree	2	4	Stongly agree	29%	18%
	Agree	4	16	Agree	57%	73%
	Not sure	1	1	Not sure	14%	5%
	Disagree	0	0	Disagree	0%	0%
	Stongly disag	0	1	Stongly disag	0%	5%
	TOTALS	7	22			

		Test Group	Control Group		Study Group	Control Group
7.I feel my work has a strong relationship to the history of architecture	Stongly agree	0	0	Stongly agree	0%	0%
	Agree	0	2	Agree	0%	9%
	Not sure	7	12	Not sure	100%	55%
	Disagree	0	6	Disagree	0%	27%
	Stongly disag	0	2	Stongly disag	0%	9%
	TOTALS	7	22			

Table H1: Phase 3 Questionnaire Responses

BIBLIOGRPAHY

ACHTEN, H., OXMAN, R. & BAX, T. Typological knowledge acquisition through a schema of generic representations. Artificial Intelligence in Design'98, 1998. Springer, 191-207.

AKIN, Ö. 2002. Case-based instruction strategies in architecture. *Design Studies,* 23**,** 407-431.

ALBERTI, L. B. 1775. *The Architecture of Leon Battista Alberti in Ten Books,* London.

ALBERTI, L. B. 1966. De re aedificatoria (1486). *Latin text and Italian trans. by G. Orlandi. Milan: publisher*.

ALEXANDER, C. 1979. *The timeless way of building*, New York: Oxford University Press.

ALEXANDER, C., ISHIKAWA, S. & SILVERSTEIN, M. 1977. *A pattern language: towns, buildings, construction*, Oxford University Press.

ALLEN, I. E. & SEAMAN, C. A. 2007. Likert scales and data analyses. *Quality progress,* 40**,** 64.

ALLFORD, S., BARR, R., COLVIN, W., COUTINHO, A., GLOSTER, D. & HERON, K. 2015. *RIBA education review* [Online]. London: RIBA. Available: https://www.architecture.com/RIBA/Becomeanarchitect/Oureducationalactivities/RIBAEducationReview [Accessed 26/01/2016 2015].

ANAY, H. A Critical Approach to the Use of Computers in Architectural Design. Digital Design: The Quest for New Paradigms: 23rd eCAADe Conference Proceedings, 2005 Lisbon, Portugal. 811-817.

ANAY, H. 2006. Creative use of Architectural Precedents in Design Education: A Framework for a Computational Model. *eCAADe, Design Theory and Computing.* Volos, Greece University of Thessaly.

ANAY, H. 2006. On the Relevance of Karl Popper's Evolutionary Epistemology for Architectural Education. *1st International CIB Endorsed METU Postgraduate Conference.* Ankara.

ANAY, H. 2007. Outline of a theory studying past architectural works. *Inernational Association of Design Research.* Hong Kong Polytechnic University.

ANAY, H. 2008. *Two Evolutionary Models for Reconceptualizing Architectural Ideas and the Architectural Design Process.* Doctor of Philosophy, Middle East Technical University.

ANDERSON, J. Undercurrent: Swimming away from the design studio. Proceedings of the first international conference of the Association of Architectural Educators--AAE:(un) common currency. Nottingham Trent University, UK. Available: http://architecturaleducators. wordpress. com/conference--2013/conference--2013--papers/(accessed: 21 July 2014), 2013.

ANDERSON, S. 1982. Types and conventions in time: Toward a history for the duration and change of artifacts. *Perspecta***,** 109-117.

ANSTEY, T., GRILLNER, K. & HUGHES, R. 2007. *Architecture and authorship,* London, Black Dog Publishing.

ARCHER, L. B. 1964. *Systematic method for designers*, Council of Industrial Design.

ARCHER, L. B. 1979. Whatever became of design methodology. *Design Studies,* 1**,** 17-18.

ARGAN, G. C. 1963. On the Typology of Architecture. *Architectural Design*.

ASIMOW, M. 1962. *Introduction to design*, Englewood Cliffs, NJ, Prentice-Hall.

BAILEY, K. 2008. *Methods of social research,* London, Simon and Schuster.

BAMFORD, G. Design, Science and Conceptual Analysis. *In:* PLUME, J., ed. Joint ANZAScA / ADTRA conference, 1991 Sydney. University NSW.

BAMFORD, G. 2002. From analysis/synthesis to conjecture/analysis: a review of Karl Popper's influence on design methodology in architecture. *Design Studies,* 23**,** 245-261.

BANERJEE, H. & GRAAFF, E. D. 1996. Problem-based learning in architecture: Problems of integration of technical disciplines. *European Journal of Engineering Education,* 21**,** 185-195.

BAUM, E. M. 2013. Comparative Anatomy: A Beginning Course in Architectural Design. *Journal of Architectural Education,* 67**,** 195-204.

BAZJANAC, V. 1974. Architectural design theory: Models of the design process. *Basic questions of design theory,* 3**,** 20.

BERTALANFFY, L. V. 1950. An Outline of General System Theory. *The British Journal for the Philosophy of Science,* 1**,** 134-165.

BERTEL, S., FREKSA, C. & VRACHLIOTIS, G. 2004. Aspectualize and conquer in architectural design. *In:* GERO, J. S., TVERSKY, B. & KNIGHT, T. (eds.) *3rd International Conference on Visual and Spatial Reasoning in Design.* MIT, Cambridge, USA: Key Centre of Design Computing and Cognition, University of Sydney.

BJÖRKLUND, T. A. 2013. Initial mental representations of design problems: Differences between experts and novices. *Design Studies,* 34**,** 135-160.

BOS, C. 2011. Typological Instruments: Connecting Architecture and Urbanism. *Architectural Design,* 81**,** 66-77.

BÖTTICHER, K. G. W. 1852. *Die tektonik der Hellenen*, Riegel.

BOUD, D. & FELETTI, G. 1997. Changing problem-based learning: Introduction to the second edition. *The challenge of problem-based learning***,** 1-14.

BOUSBACI, R. 2008. "Models of Man" in Design Thinking: The "Bounded Rationality" Episode. *Design Issues,* 24**,** 38-52.

BRACHT, G. H. & GLASS, G. V. 1968. The external validity of experiments. *American educational research journal*, 437-474.

BRAHAM, W. W. 2000. After Typology: The Suffering of Diagrams. *Architectural Design, "Contemporary Processes in Architecture",* 70, 9-11.

BRAWNE, M. 1992. *From idea to building: issues in architecture,* Oxford, Butterworth-Heinemann.

BRAWNE, M. 2003. *Architectural Thought: The Design Process and the Expectant Eye,* Oxford, Architectural Press.

BRITISH EDUCATIONAL RESEARCH ASSOCIATION. 2011. *Ethical Guidelines for Educational Research* [Online]. Available: https://www.bera.ac.uk/wp-content/uploads/2014/02/BERA-Ethical-Guidelines-2011.pdf [Accessed 22 May 2016 2016].

BUCHANAN, R. 1992. Wicked Problems in Design Thinking. *Design Issues,* 8, 5-21.

CAMPBELL, D. T. & STANLEY, J. C. 1963. *Experimental and quasi-experimental designs for research on teaching*, American Educational Research Association.

CARL, P. 2011. Type, Field, Culture, Praxis. *Architectural Design,* 81, 38-45.

CARLESS, D. 2015. Exploring learning-oriented assessment processes. *Higher Education,* 69, 963-976.

CARUSO, A. C. 2008. Toward and evolution of studio culture: a report of the second aias task force on studio culture. Washington DC: American Institute of Architecture Students.

CASAKIN, H. 2004. Metaphors in the Design Studio: Implications for Education. *International Engineering and Product Design Education Conference.* Delft, The Netherlands.

CASAKIN, H. 2006. Assessing the use of metaphors in the design process. *Environment and Planning B: Planning and Design,* 33, 253-268.

CASAKIN, H. 2011. Metaphorical reasoning and design expertise. *Journal of Learning Design,* 4, 29-38.

CASAKIN, H. & DAI, W. 2002. Visual typology in design: A computational view. *Artificial Intelligence for Engineering Design, Analysis and Manufacturing,* 16, 3-21.

CASAKIN, H. & MILLER, K. 2007. An investigation of metaphor use and learning style in design problem solving. *International conference on engineering and product design education.* Northumbria University, Newcastle-upon-Tyne, UK.

CELENTO, D. 2007. Innovate or Perish. *Harvard Design Magazine,* 27.

CENNAMO, K. & BRANDT, C. 2012. The “right kind of telling”: Knowledge building in the academic design studio. *Educational Technology Research and Development,* 60, 839-858.

CENNAMO, K., BRANDT, C., SCOTT, B., DOUGLAS, S., MCGRATH, M., REIMER, Y. & VERNON, M. 2011. Managing the complexity of design problems

through studio-based learning. *Interdisciplinary Journal of Problem-based Learning,* 5**,** 5.

CHENG, R. 2014. Designers Designing Design Education. *Journal of Architectural Education,* 68**,** 12-14.

CHURCHMAN, C. W. 1967. Guest editorial: Wicked problems. JSTOR.

CIMADOMO, G. 2014. Teaching history of architecture-moving from a knowledge transfer to a multi-participative methodology based on it tools. *Journal of Learning Design,* 7.

CLARK, R. H. & PAUSE, M. 2012. *Precedents in architecture: analytic diagrams, formative ideas, and partis,* London, John Wiley & Sons.

COCKERTON, T., NAZ, R. & SHEPPARD, S. 2002. Factorial validity and internal reliability of Honey and Mumford's Learning Styles Questionnaire. *Psychological reports,* 91**,** 503-519.

COHEN, L., MANION, L. & MORRISON, K. 2000. Research Methods in Education [5 th edn] London: Routledge Falmer. *Teaching in Higher Education,* 41.

COLQUHOUN, A. 1969. Typology and Design Method. *Perspecta,* 12**,** 71-74.

CORBUSIER, L. 1987. *The city of to-morrow and its planning*, Courier Corporation.

COYNE, R. 2005. Wicked problems revisited. *Design Studies,* 26**,** 5-17.

COYNE, R. & SNODGRASS, A. 1995. Problem setting within prevalent metaphors of design. *Design Issues***,** 31-61.

CRIMSOND, D., P. & ADAMS, R., S. 2012. The Informed Design Teaching and Learning Matrix. *Journal of Engineering Education,* 101**,** 738-797.

CROSS, N. 1972. *Design participation,* Michigan, Academy Editions.

CROSS, N. 1982. Designerly ways of knowing. *Design Studies,* 3**,** 221-227.

CROSS, N. 2007. Forty years of design research. *Design Studies,* 28**,** 1-4.

CROSS, N. 2008. *Engineering design methods: strategies for product design,* London, John Wiley & Sons.

CROSS, N. & CROSS, A. C. 1996. Winning by design: the methods of Gordon Murray, racing car designer. *Design studies,* 17**,** 91-107.

CROWE, N. 2014. Studies in Typology. *Journal of Architectural Education,* 38**,** 10-13.

CROWTHER-HEYCK, H. 2005. *Herbert A. Simon: The bounds of reason in modern America,* Baltimore, JHU Press.

CURRY, T. 2014. A theoretical basis for recommending the use of design methodologies as teaching strategies in the design studio. *Design Studies,* 35**,** 632-646.

DARKE, J. 1979. The primary generator and the design process. *Design Studies,* 1**,** 36-44.

DARKE, J. 1984. The primary generator and the design process. Developments in Design Methodology. New York: Nigel Cross.

DAVIS, L. 1996. Ordering Space: Types in Architecture and Design by Karen A. Frank; Lynda H. Schneekloth Review. *Journal of Architectural Education,* 50**,** 128-130.

DE JONG, T. M. & ENGEL, H. 2002. Typological Research. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

DE LA HARPE, B., PETERSON, J. F., FRANKHAM, N., ZEHNER, R., NEALE, D., MUSGRAVE, E. & MCDERMOTT, R. 2009. Assessment focus in studio: What is most prominent in architecture, art and design? *International Journal of Art & Design Education,* 28**,** 37-51.

DEAKIN, M. 2006. Research Led Teaching: a Review of Two Initiatives in Valuing the Link Between Teaching and Research. *Journal for Education in the Built Environment,* 1**,** 73-93.

DEFAZIO, J. 2008. *Designing with precedent: A cross-disciplinary inquiry into the design process.* Doctor of Philosophy, Indiana University.

DELEUZE, G. & GUATTARI, F. 1988. *A thousand plateaus: Capitalism and schizophrenia,* London, Bloomsbury Publishing.

DOBOLI, A. & UMBARKAR, A. 2014. The role of precedents in increasing creativity during iterative design of electronic embedded systems. *Design Studies,* 35**,** 298-326.

DORST, K. 1995. Analysing design activity: new directions in protocol analysis. *Design Studies,* 16**,** 139-142.

DORST, K. 2006. Design problems and design paradoxes. *Design issues,* 22**,** 4-17.

DORST, K. 2011. The core of 'design thinking'and its application. *Design studies,* 32**,** 521-532.

DORST, K. & CROSS, N. 2001. Creativity in the design process: co-evolution of problem–solution. *Design studies,* 22**,** 425-437.

DOXATER, D. 1983. Spatio symbolic oppositions in ritual and architecture. *Design Studies,* 4**,** 124-132.

DURAND, J. N. L. 1809. *Précis des leçons d'architecture données à l'École polytechnique,* Paris, chez l'auteur, à l'Ecole polytechnique.

ECK, C. V. 1998. The Structure of "De re aedificatoria" Reconsidered. *Journal of the Society of Architectural Historians,* 57**,** 280-297.

EGGENER, K. L. 2002. Placing Resistance: A Critique of Critical Regionalism. *Journal of Architectural Education,* 55**,** 228-237.

EILOUTI, B. H. 2009. Design knowledge recycling using precedent-based analysis and synthesis models. *Design Studies,* 30**,** 340-368.

ESRC 2015. Economic and Social Research Council Delivery Plan 2015-16. Swindon: Economic and Social Research Council

EU 2014. Directive 2005/36/EC of the European Parliament and of the Council of 7 September 2005 on the recognition of professional qualifications. *In:* PARLIAMENT, E. (ed.).

EVBUOMWAN, N., SIVALOGANATHAN, S. & JEBB, A. 1996. A survey of design philosophies, models, methods and systems. *Proceedings of the Institution of Mechanical Engineers, Part B: Journal of Engineering Manufacture,* 210**,** 301-320.

FALUDI, A. 1983. Critical Rationalism and Planning Methodology. *Urban Studies,* 20**,** 265-278.

FANG 1993. *A knowledge based computational approach to architectural precedent anlysis,* Delf, Publikatieburo Bouwkunde.

FLEMMING, U. & AYGEN, Z. 2001. A hybrid representation of architectural precedents. *Automation in Construction,* 10**,** 687-699.

FRAENKEL, B., ASSAEL, J., COE, P., BRENNAN, R. & EISNER, H. 2015. *Minutes of Board Meeting held on 17/09/15* [Online]. London: ARB. Available: http://www.arb.org.uk/files/files/Open%20minutes%2017%20September%202015%20for%20web.pdf [Accessed 26/01/2016 2016].

FRAMPTON, K. 1983. Towards a Critical Regionalism: Six Points for an Architecture of Resistance. *Anti-Aesthetic. Essays on Postmodern Culture.* Seattle: Bay Press.

FREESTONE, R. & WOOD, D. 2006. Exploring Strategies for Linking Research and Teaching. *Journal for Education in the Built Environment,* 1**,** 94-111.

FRENCH, M. J. 1985. *Conceptual design for engineers,* London, Springer-Verlag.

FRIED, M. 1986. Antiquity Now: Reading Winckelmann on Imitation. *October,* 37**,** 87-97.

GALLE, P. 1993. Review: 'From idea to building. Issues in architecture' by M Brawne. *Environment and Planning B: Planning and Design,* 20**,** 729-740.

GARDNER, H. 1988. 12 Creative lives and creative works: a synthetic scientific approach. *The nature of creativity: Contemporary psychological perspectives***,** 298.

GEDENRYD, H. 1998. *How designers work-making sense of authentic cognitive activities,* Lund, Lund University.

GIJBELS, D., DOCHY, F., VAN DEN BOSSCHE, P. & SEGERS, M. 2005. Effects of problem-based learning: A meta-analysis from the angle of assessment. *Review of educational research,* 75**,** 27-61.

GIROT, C. 2005. *Vers une nouvelle nature,* Zurich, GTA Verlag.

GLASER, B. G. & STRAUSS, A. L. 2009. *The discovery of grounded theory: Strategies for qualitative research,* New Jersey, Transaction Publishers.

GOFFMAN, E. 1974. *Frame analysis: An essay on the organization of experience,* Cambridge, MA, Harvard University Press.

GOLD, R. L. 1958. Roles in sociological field observations. *Social forces***,** 217-223.

GOMBRICH, E. H. 1960. Art and illusion: A study in the psychology of pictorial representation. *Bollingen Ser. XXXV***,** 9.

GONÇALVES, M., CARDOSO, C. & BADKE-SCHAUB, P. 2014. What inspires designers? Preferences on inspirational approaches during idea generation. *Design studies,* 35**,** 29-53.

GROAT, L. & WANG, D. 2002. *Architectural research methods,* New York, Wiley.

GUBA, E. G. & LINCOLN, Y. S. 1994. Competing paradigms in qualitative research. *In:* DENZIN, N. K. & LINCOLN, Y. S. (eds.) *Handbook of qualitative research.* California: Sage.

GÜLER, K. 2015. Social media-based learning in the design studio: A comparative study. *Computers & Education,* 87**,** 192-203.

GULGONEN, A. & LAISNEY, F. 1982. Contextual Approaches to Typology at the Ecole des Beaux-Arts. *Journal of Architectural Education,* 35**,** 26-28.

GUMIENNY, R., LINDBERG, T. & MEINEL, C. 2011. Exploring the synthesis of information in design processes - opening the black box. *International conference on engineering design.* Technical University of Denmark.

GÜNEY, Y., I. 2007. Type and typology in architectural discourse. *BAÜ FBE Dergisi,* 9**,** 3-18.

GUTSCHOW, K. K. Restructuring Architecture's History: Historicism in Karl Bötticher's Theory of Tectonics. (Re)Viewing the Tectonic Collegiate Schools of Architecture Regional Conference, 2000 University of Michigan.

HALE, J. A. 2005. Gottfried Semper's primitive hut as an act of self-creation. *Architectural Research Quarterly,* 9**,** 45-49.

HAMMERSLEY, M. & TRAIANOU, A. 2012. *Ethics and Educational Research, British Educational Research Association on-line resource* [Online]. BERA. Available: https://www.bera.ac.uk/wp-content/uploads/2014/03/Ethics-and-Educational-Research.pdf?noredirect=1 [Accessed 26.02.2016 2016].

HANSEN, C. T. & ANDREASEN, M. M. On the content of design problems. DS 50: Proceedings of NordDesign Conference, 2008 Tallinn, Estonia.

HANSEN, C. T., DORST, K. & ANDREASEN, M. M. Problem formulation as a discursive design activity. DS 58-1: Proceedings of ICED 09, the 17th International Conference on Engineering Design, 2009 Palo Alto, CA, USA.

HARRIS, A. 1980. Can design be taught. *Proceedings of Institution of Civil Engineers part,* 1**,** 68.

HARTOONIAN, G. 2007. In What Style Could They Have Built? *Fabrications,* 17**,** 72-91.

HATCHUEL, A. 2001. Towards Design Theory and Expandable Rationality: The Unfinished Program of Herbert Simon. *Journal of Management and Governance,* 5**,** 260-273.

HENRY HOME, L. K. 2007. *Sketches of the History of Man,* Indianapolis, Liberty Fund.

HERON, J. 1976. A six-category intervention analysis. *British Journal of Guidance and Counselling,* 4**,** 143-155.

HEY, J., VAN PELT, A., AGOGINO, A. & BECKMAN, S. 2007. Self-reflection: Lessons learned in a new product development class. *Journal of Mechanical Design,* 129**,** 668-676.

HEYLIGHEN, A., NEUCKERMANS, H., CASAER, M. & DEWULF, G. P. M. 2007. Building Memories. *Building Research and Information,* 35**,** 90-100.

HEYLIGHEN, A. & VERSTIJNEN, I. M. 2003. Close encounters of the architectural kind. *Design Studies,* 24**,** 313-326.

HILLIER, B., MUSGROVE, J. & O'SULLIVAN, P. 1972. Knowledge and Design. *In:* MITCHELL, W. J. (ed.) *Environmental Design Research and Practice.* University of California.

HOLT, J. E., RADCLIFFE, D. F. & SCHOORL, D. 1985. Design or problem solving — a critical choice for the engineering profession. *Design Studies,* 6**,** 107-110.

HUBKA, V. & EDER, W. E. 1988. *Theory of technical systems: A total concept theory for engineering design,* Berlin and New York, Springer-Verlag.

HUBKA, V. & EDER, W. E. 2012. *Theory of technical systems: a total concept theory for engineering design*, Springer Science & Business Media.

HULT, L., IRESTIG, M. & LUNDBERG, J. 2006. Design Perspectives. *Human Computer Interaction,* 21**,** 5-48.

HVATTUM, M. 2001. Gottfried Semper: Between Poetics and Practical Aesthetics. *Zeitschrift für Kunstgeschichte,* 64**,** 537-546.

HVATTUM, M. 2004. *Gottfried Semper and the Problem of Historicism,* Cambidge, UK, Cambridge University Press.

JACOBY, S. 2013. *The Reasoning of Architecture: Type and the Problem of Historicity.* Doctor of Philosophy, Technischen Universität Berlin.

JACOBY, S. & LEE, C. C. 2011. Typological urbanism and the idea of the city. *Architectural Design,* 81**,** 14-23.

JÄNSCH, J. & BIRKHOFER, H. The development of the guideline VDI 2221-the change of direction. DS 36: Proceedings DESIGN, the 9th International Design Conference, 2006 Dubrovnik, Croatia.

JENCKS, C. 2006. The iconic building is here to stay. *City: analysis of urban trends, culture, theory, policy, action,* 10**,** 3-20.

JENCKS, C. 2015. *In what style shall we build* [Online]. http://www.architectural-review.com/essays/in-what-style-shall-we-build/8679048.article?blocktitle=Top-Stories&contentID=11974: Architectural Review. [Accessed 13 March 2015].

JOHANNES, R. 1992. Architectural Design: a systematic approach: part 1. *Design Studies,* 13**,** 71-86.

JOHANSSON-SKÖLDBERG, U., WOODILLA, J. & ÇETINKAYA, M. 2013. Design Thinking: Past, Present and Possible Futures. *Creativity and Innovation Management,* 22**,** 121-146.

JOHNSON, P.-A. 1994. *The Theory of Architecture: Concepts Themes & Practices,* London, John Wiley & Sons.

JONAS, W. 1993. Design as problem-solving? or: Here is the solution —what was the problem? *Design Studies,* 14**,** 157-170.

KÄRRHOLM, M. 2013. Building type production and everyday life: rethinking building types through actor-network theory and object-oriented philosophy. *Environment and Planning D: Society and Space,* 31**,** 1109-1124.

KAUFMANN, E. 1957. *Architecture in the Age of Reason. Baroque and Post-Baroque in England, Italy and France,* Cambridge, MA, Harvard University Press.

KIMBELL, L. 2011. Rethinking design thinking: Part I. *Design and Culture,* 3**,** 285-306.

KINNEY, L. W. 1999. Fashion and Fabrication in Modern Architecture. *Journal of the Society of Architectural Historians,* 58**,** 472-481.

KINSELLA, E. A. 2006. Constructivist underpinnings in Donald Schön's theory of reflective practice: Echoes of Nelson Goodman. *Reflective Practice,* 7**,** 277-286.

KLEIN, A. 1934. Das Einfamilienhaus. *Südtyp: Studien und Entwürfe mit grundsätzlichen Betrachtungen*.

KOLB, D. 1985. *Learning-Style Inventory: Self-Scoring Inventory and Interpretation Booklet Boston,* Boston, MA, Hay/McBer.

KOLODNER, J. L. 1992. An introduction to Case-Based Reasoning. *Artificial Intelligence Review,* 6**,** 3-34.

KOWALTOWSKI, D. C. C. K., BIANCHI, G. & DE PAIVA, V. T. 2009. Methods that may stimulate creativity and their use in architectural design education. *International Journal of Technology and Design Education,* 20**,** 453-476.

KOYRÉ, A. 1958. *From the closed world to the infinite universe*, Library of Alexandria.

KRICK, E. V. 1965. *An introduction to engineering and engineering design,* London, John Wiley.

KRIER, R., SCHNERIDER, R. & VORREITER, G. 1988. *Architectural composition,* New York, Rizzoli

KRIPPENDORFF, K. & BUTTER, R. 2007. Semantics: Meanings and contexts of artifacts. *In:* SCHIFFERSTEIN, H. N. J. & HEKKERT, P. (eds.) *Product experience.* New York: Elsevier.

KUHN, S. 2001. Learning from the architecture studio: Implications for project-based pedagogy. *International Journal of Engineering Education,* 17**,** 349-352.

KVAN, T. & JIA, Y. 2005. Students' learning styles and their correlation with performance in architectural design studio. *Design Studies,* 26**,** 19-34.

LANS, W. & VAN DER VOORDT, T. 2002. Descriptive Research. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

LATHOURI, M. 2011. The City as a Project: Types, Typical Objects and Typologies. *Architectural Design,* 81**,** 24-31.

LAUGIER, M. A. 1755. *Essai sur l'architecture,* Paris, Duchesne.

LAVIN, S. 1992. *Quatremere de Quincy,* Cambridge, MA, MIT Press.

LAWRENCE, R. J. 1983. The interpretation of vernacular architecture. *Vernacular Architecture,* 14**,** 19-28.

LAWSON, B. 1994. *Design in mind,* Oxford, Butterworth Architecture.

LAWSON, B. 2006. *How designers think: the design process demystified,* Oxford, Routledge.

LAWSON, B. R. 1979. Cognitive strategies in architectural design. *Ergonomics,* 22**,** 59-68.

LEDEWITZ, S. 1985. Models of design in studio teaching. *Journal of Architectural Education,* 38**,** 2-8.

LEDEWITZ, S. 1985. Models of design in studio teaching. *Journal of Architectural Education,* 38**,** 2-8.

LEHRDAL, E. 2001. *Staging for creative collaboration in design teams. Models, tools and methods.* NTNU.

LEUPEN, B. 2002. Concept and Type. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

LEVY, A. 1980. Total studio. *Journal of architectural education,* 34**,** 29-32.

LEWIS-BECK, M. S. 1993. *Experimental design and methods,* London, Sage Publications.

LIE, U. 2011. *Framing an eclectic practice; Historical models and narratives of product design as professional work.* Philosophiae Doctor, Norwegian University of Science and Technology.

LIKERT, R. 1932. A technique for the measurement of attitudes. *Archives of psychology*.

LINCOLN, Y. S. & GUBA, E. G. 1985. *Naturalistic inquiry,* London, Sage.

LIPMAN, A. & SURMA, P. 1986. Aldo Rossi, architect, scientist - a storm of silence...an architecture of alienation. *Design Studies,* 7**,** 58-66.

LOZANO, E., GRACIA, J., CORCHO, O., NOBLE, R. A. & GÓMEZ-PÉREZ, A. 2015. Problem-based learning supported by semantic techniques. *Interactive Learning Environments,* 23**,** 37-54.

MADRAZO, L. 1994. Durand and the Science of Architecture. *Journal of Architectural Education,* 48**,** 12-24.

MAHER, M. L. & GÓMEZ DE SILVA GARZA, A. S. 1997. Case-Based Reasoning in Design. *IEEE Intelligent Systems,* 12**,** 34-41.

MAHER, M. L. & POON, J. 1996. Modeling design exploration as co-evolution. *Computer-Aided Civil and Infrastructure Engineering,* 11**,** 195-209.

MALLGRAVE, H. F. 1985. Review of Gottfried Semper: In Search of Architecture. *Journal of Architectural Education* 38**,** 33-34.

MARPLES, D. L. 1961. The decisions of engineering design. *Engineering Management, IRE Transactions on***,** 55-71.

MARTIN, P. Y. & TURNER, B. A. 1986. Grounded theory and organizational research. *The Journal of Applied Behavioral Science,* 22**,** 141-157.

MAXWELL, N. 2007. The Enlightenment, Popper and Einstein. *Advances in Multiple Criteria Decision Making and Human Systems Management: Knowledge and Wisdom***,** 131-148.

MAXWELL, N. 2007. The Enlightenment, Popper and Einstein. *Advances in Multiple Criteria Decision Making and Human Systems Management: Knowledge and Wisdom***,** 131-148.

MCALOONE, T. C. & BEY, N. 2009. *Environmental improvement through product development: A guide*, Danish Environmental Proteciton Agency.

MCCLEAN, D. 2009. *Embedding learner independence in architecture education: reconsidering design studio pedagogy.* Doctor of Philosophy, Robert Gordon University.

MCDONNELL, J. 2016. Scaffolding practices: A study of design practitioner engagement in design education. *Design Studies,* 45**,** 9-29.

MCNEILL, P. & CHAPMAN, S. 2005. *Research methods,* Oxford, Psychology Press.

MEADOWS, D. H., MEADOWS, N. L., RANDERS, J. & BEHRENS, W. 1974. *The Limits to Growth: A Report for the Club of Rome's Project on the Predicament of Mankind [By] Donella H. Meadows [And Others]. 2d Ed*, Universe Books.

MENG, J. C. S. 2009. Donald Schön, Herbert Simon and the sciences of the artificial. *Design Studies,* 30**,** 60-68.

MIKE MARTIN, W., HEYLIGHEN, A. & CAVALLIN, H. 2003. Building? Stories. A hermeneutic approach to studying design practice. *Design pedagogy: basic design and academic experiences*.

MILES, M. B. & HUBERMAN, A. M. 1994. *Qualitative data analysis: An expanded sourcebook,* London, Sage.

MINSKY, M. 1974. A framework for representing knowledge. Cambridge, MA, USA: MIT.

MOBLEY, M. I., DOARES, L. M. & MUMFORD, M. D. 1992. Process analytic models of creative capacities: Evidence for the combination and reorganization process. *Creativity Research Journal,* 5**,** 125-155.

MOLEMA, J. 2002. Analysis of buildings. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

MONEO, R. 1978. On Typology. *Oppositions,* 13**,** 22-45.

MORENO, D. P., HERNÁNDEZ, A. A., YANG, M. C., OTTO, K. N., HÖLTTÄ-OTTO, K., LINSEY, J. S., WOOD, K. L. & LINDEN, A. 2014. Fundamental studies in Design-by-Analogy: A focus on domain-knowledge experts and applications to transactional design problems. *Design Studies,* 35**,** 232-272.

MORRIS, E. K. 1980. Teaching history typologically. *Journal of Architectural Education,* 34**,** 27-28.

MORRIS, E. K. 1982. Architectural type and institutional programme. *Journal of Architectural Education,* 35**,** 17-25.

MOUSSAVI, F., CIANCARELLA, M., SCELSA, J. A., CRETTIER, M. & KILALEA, K. 2014. *The Function of Style,* Barcelona, Actar.

MOUSSAVI, F., KUBO, M. & HOFFMAN, S. 2006. *The function of ornament,* Barcelona, Actar.

MULLER, J. 2015. The future of knowledge and skills in science and technology higher education. *Higher Education,* 70**,** 409-416.

MULLER, W. & PASMAN, G. 1996. Typology and the organization of design knowledge. *Design Studies,* 17**,** 111-130.

MUMFORD, M. D., MOBLEY, M. I., REITER-PALMON, R., UHLMAN, C. E. & DOARES, L. M. 1991. Process analytic models of creative capacities. *Creativity Research Journal,* 4**,** 91-122.

MURBARAK, K. 2004. *Case Based Reasoning for Design Composition in Architecture.* Doctor of Philosophy, Carnegie Mellon University.

NATIONAL STUDENT SURVEY. 2015. Available: https://unistats.direct.gov.uk/Subjects/Overview/10007850FT-UUUR1-K100~UEAR-ANB08 [Accessed 31/01/16 2016].

NELSON, B. A., WILSON, J. O., ROSEN, D. & YEN, J. 2009. Refined metrics for measuring ideation effectiveness. *Design Studies,* 30**,** 737-743.

NESBITT, K. 1996. *Theorizing a New Agenda for Architecture:: An Anthology of Architectural Theory 1965-1995*, Princeton Architectural Press.

NESBITT, K. & SPERLING, D. 2001. Fleet purchase behavior: decision processes and implications for new vehicle technologies and fuels. *Transportation Research Part C: Emerging Technologies,* 9**,** 297-318.

NEWELL, A., SHAW, J. C. & SIMON, H. A. 1958. Elements of a theory of human problem solving. *Psychological review,* 65**,** 151.

NEWELL, A., SHAW, J. C. & SIMON, H. A. 1959. *The processes of creative thinking,* Santa Monica, CA, Rand Corporation

NEWELL, A. & SIMON, H. A. 1972. *Human problem solving,* Englewood Cliffs, NJ, Prentice-Hall

OECHSLIN, W. 1986. Premises for the Resumption of the Discussion of Typology. *Assemblage***,** 37-53.

OSTWALD, M. J. & WILLIAMS, A. 2008. An Analysis of Architecture Schools, Programs, Academics and Students. *Understanding Architectural Education in Australasia.* Australia: Australian Learning and Teaching Council.

OSTWALD, M. J. & WILLIAMS, A. 2008. Results and Recommendations. *Understanding Architectural Education in Australasia.* Australia: Association of Architecture Schools of Australasia.

OXMAN, R. 2004. Think-maps: teaching design thinking in design education. *Design Studies,* 25**,** 63-91.

OXMAN, R. & OXMAN, R. 1993. Remembrance of things past: design precedents in libraries. *Automation in Construction,* 2**,** 21-29.

PADOVAN, R. 2002. *Towards universality: Le Corbusier, Mies and De Stijl,* Oxford, Routledge.

PAHL, G., BEITZ, W., FELDHUSEN, J. & GROTE, K.-H. 2007. *Engineering design: a systematic approach*, Springer Science & Business Media.

PATON, B. & DORST, K. 2011. Briefing and reframing: A situated practice. *Design Studies,* 32**,** 573-587.

PETRUCCIOLI, A. 1998. *Typological process and design theory,* Cambridge MA, Aga Khan Program for Islamic Architecture.

PFEIFER, G. & BRAUNECK, P. 2007. *Courtyard houses: a housing typology,* Berlin, Walter de Gruyter.

POPPER, K. 2014. *Conjectures and refutations: The growth of scientific knowledge,* London, Routledge and Kegan Paul.

POPPER, K. R. 1959. *The logic of scientific discovery,* London, Hutchinson.

PORPHYRIOS, D. 1991. *Classical architecture,* London, Andreas Papadakis Publisher.

POWELL, J. A. 1987. Is architectural design a trivial pursuit? *Design Studies,* 8**,** 187-206.

QAA 2010. Subject Benchmark Statement: Architecture. Gloucester.

QUATREMÈRE DE QUINCY, A. 1832. *Dictionnaire historique d'architecture,* Paris, le Clere.

RECKWITZ, A. 2002. Toward a Theory of Social Practices: A Development in Culturalist Theorizing. *European Journal of Social Theory,* 5**,** 243-263.

REIMER, Y. J. & DOUGLAS, S. A. 2003. Teaching HCI design with the studio approach. *Computer science education,* 13**,** 191-205.

REIMER, Y. J. & DOUGLAS, S. A. 2003. Teaching HCI design with the studio approach. *Computer science education,* 13**,** 191-205.

RESTREPO, J., CHRISTIAANS, H. & GREEN, W. S. 2004. Give me an Example: Supporting the Creative Designer. *Computers in Art and Design*

RITTEL, H. W. 1972. *On the Planning Crisis: Systems Analysis of the" First and Second Generations"*, Institute of Urban and Regional Development.

RITTEL, H. W. J. & WEBBER, M. M. 1973. Dilemmas in a General Theory of Planning. *Policy Sciences,* 4**,** 155-169.

ROBERTS, A. 2007. The Link between Research and Teaching in Architecture. *Journal for Education in the Built Environment,* 2**,** 3-20.

ROETHLISBERGER, F. J. & DICKSON, W. J. 1939. *Management and the Worker,* Cambridge MA, Harvard University Press.

ROOZENBURG, N. & CROSS, N. 1991. Models of the design process: integrating across the disciplines. *Design Studies,* 12**,** 215-220.

ROOZENBURG, N. F. & EEKELS, J. 1995. *Product design: fundamentals and methods,* Chichester, Wiley.

ROSSI, A., EISENMAN, P., GHIRARDO, D. & OCKMAN, J. 1982. *The architecture of the city,* Cambridge, MA, MIT Press

ROWE, C. 1996. Program vs Paradigm. *The Cornell Journal of Architecture,* 1**,** 9-19.

ROWE, P. G. 1982. A Priori Knowledge and Heuristic Reasoning in Architectural Design. *JAE,* 36**,** 18-23.

ROWE, P. G. 1987. *Design thinking,* Cambridge, MA, MIT Press.

ROWLAND, I. D. & HOWE, T. N. 2001. *Vitruvius: 'Ten Books on Architecture'*, Cambridge University Press.

ROYAL INSTITUTE OF BRITISH ARCHITECTS. 2013. *Plan of Work* [Online]. RIBA. Available: https://www.ribaplanofwork.com [Accessed 23 May 2016].

SALAMA, A. M. & WILKINSON, N. 2007. *Design studio pedagogy: Horizons for the future*, Arti-Arch.

SANDALACK, B. A. & URIBE, F. G. A. 2010. Open Space Typology as a Framework for Design of the Public Realm. *The Faces of Urbanized Space.*

SANOFF, H. 2007. Special issue on participatory design. *Design Studies,* 28**,** 213-215.

SCHEURICH, J. J. 1995. A postmodernist critique of research interviewing. *International Journal of Qualitative Studies in Education,* 8**,** 239-252.

SCHMITT, G. 1993. Case-Based Design and Creativity. *Automation in Construction,* 2**,** 11-19.

SCHÖN, D., A. 1984. Problems, frames and perspectives on designing. *Design Studies***,** 132-136.

SCHÖN, D., A. 1985. *The Design Studio,* London, RIBA Publications Ltd.

SCHÖN, D., A. 1988. Designing rules types and worlds. *Design Studies,* 9**,** 181-190.

SCHON, D. A. 1992. Designing as reflective conversation with the materials of a design situation. *Research in Engineering Design,* 3**,** 131-147.

SCHÖN, D. A. 1988. Toward a marriage of artistry & applied science in the architectural design studio. *Journal of Architectural Education,* 41**,** 4-10.

SCHURZ, G. 2008. Patterns of abduction. *Synthese,* 164**,** 201-234.

SCHWARZER, M. 1993. Ontology and Representation in Karl Botticher's Theory of Tectonics. *Journal of the Society of Architectural Historians,* 52**,** 267-280.

SEBEOK, T. A. 1976. Inconicity. *MLN,* 91**,** 1427-1456.

SHAFFER, D. W. 2005. Studio Mathematics: The Epistemology and Practice of Design Pedagogy as a Model for Mathematics Learning. *Wisconsin Center for Education Research (NJ1),* 3.

SHAH, J. J., SMITH, S. M. & VARGAS-HERNANDEZ, N. 2003. Metrics for measuring ideation effectiveness. *Design studies,* 24**,** 111-134.

SHIELDS, P. M. & TAJALLI, H. 2006. Intermediate theory: The missing link in successful student scholarship. *Journal of Public Affairs Education***,** 313-334.

SIMON, H. A. 1969. The Science of Design: Creating the Artificial. *The sciences of the artificial.* Cambridge, MA: MIT.

SIMON, H. A. 1977. The Structure of Ill-Structured Problems. *Models of Discovery.* Netherlands: Springer.

SIMON, H. A. 1977. The organization of complex systems. *Models of discovery.* Netherlands: Springer.

SIMON, H. A. 1996. *The sciences of the artificial,* Cambridge MA, MIT press.

SIO, U. N., KOTOVSKY, K. & CAGAN, J. 2015. Fixation or inspiration? A meta-analytic review of the role of examples on design processes. *Design Studies,*

SMITH, C. 2014. Fusing technology and design in the studio. *Charrette,* 1**,** 115-126.

SMITH, D., HEDLEY, P. & MOLLOY, M. 2009. Design learning: a reflective model. *Design Studies,* 30**,** 13-37.

SMITHIES, K., W. 1981. *Principles of Design in Architecture,* Berkshire, Van Nostrand Reinhold Company Ltd.

SNODGRASS, A. & COYNE, R. 1992. Models, metaphors and the hermeneutics of designing. *Design Issues***,** 56-74.

SNODGRASS, A. & COYNE, R. 2013. *Interpretation in architecture: design as way of thinking,* Oxford, Routledge.

SNOEK, H. & HEKKERT, P. 1999. Directing designers towards innovative solutions. *Managing new product innovation***,** 167-180.

SOBEK II, D. K. & JAIN, V. K. 2004. Two Instruments for Assessing Design Outcomes of Capstone Projects. *American Society for Engineering Education Annual Conference & Exposition.* American Society for Engineering Education.

SOO MENG, J. C. 2009. Donald Schön, Herbert Simon and The Sciences of the Artificial. *Design Studies,* 30**,** 60-68.

SPELMAN, E. R. 1997. *Gottfried Semper and profound surface of architecture.* Master of Architecture, Rice University.

STAPLES, M. 2015. Critical rationalism and engineering: methodology. *Synthese,* 192**,** 337-362.

STEADMAN, P. 1979. *The evolution of designs,* Oxford, Routledge

STEADMAN, P. 2014. Generative Design Methods and the Exploration of Worlds of Formal Possibility. *Architectural Design.* London: John Wiley and Sons.

STEADMAN, P. & MITCHELL, L. J. 2010. Architectural morphospace: mapping worlds of built forms. *Environment and Planning B: Planning and Design,* 37**,** 197-220.

STEVENS, G. 1995. Struggle in the studio: A Bourdivin look at architectural pedagogy. *Journal of Architectural Education,* 49**,** 105-122.

SUH, N. P. 1990. *The principles of design,* New York, Oxford University Press

TATE, D. & NORDLUND, M. A design process roadmap as a general tool for structuring and supporting design activities. Proceedings of the Second World Conference on Integrated Design and Process Technology (IDPT), 1996. Citeseer, 1-4.

THORNLEY, D. G. 1962. Design Method in Architectural Education. *In:* JONES, J. C. & THORNLEY, D. G. (eds.) *Papers presented at the Conference on Systematic and Intuitive Methods in Engineering, Industrial Design, Architecture and Communications.* London: Pergamon.

TICE, J. 1993. Theme and Variations: A Typological Approach to Housing Design, Teaching, and Research. *Journal of Architectural Education,* 46**,** 162-175.

TILL, J. 2003. Lost judgement. *EAAE Prize,* 2005**,** 164-181.

TOMIYAMA, T., TAKEDA, H., YOSHIOKA, M. & SHIMOMURA, Y. Abduction for creative design. ASME 2003 International Design Engineering Technical

Conferences and Computers and Information in Engineering Conference, 2003. American Society of Mechanical Engineers, 543-552.

TSENG, I., MOSS, J., CAGAN, J. & KOTOVSKY, K. 2008. The role of timing and analogical similarity in the stimulation of idea generation in design. *Design Studies,* 29**,** 203-221.

TUCKER, R. & REYNOLDS, C. 2006. The Impact of Teaching Models, Group Structures and Assessment Modes on Cooperative Learning in the Student Design Studio. *Journal for Education in the Built Environment,* 1**,** 39-56.

TUNÇER, E. B. 2009. *The Architectural Information Map.* Doctor of Philosophy, Technische Universiteit Delft.

TURNER, B. A. 1983. THE USE OF GROUNDED THEORY FOR THE QUALITATIVE ANALYSIS OF ORGANIZATIONAL BEHAVIOUR. *Journal of Management Studies,* 20**,** 333-348.

UNIVERSITY OF BATH. 2014. *Code of Good Practice in Research Integrity* [Online]. Bath: University of Bath. Available: http://www.bath.ac.uk/opp/docs/code-of-good-practice-in-research-integrity.pdf [Accessed 21/06/2016 2016].

URBAN, F. 2013. *Tower and slab: histories of global mass housing,* London, Routledge.

VAN DER VOORDT, T. 2002. Evaluating Prototypes. *In:* DE JONG, T. M. & VAN DER VOORDT, D. J. M. (eds.) *Ways to study and research: urban, architectural and technical design.* Delft: IOS Press.

VDI. 1993. *Systematic approach to the development and design of technical systems and products* [Online]. Germany: VDI. Available: http://www.vdi.eu/nc/guidelines/vdi_2221-methodik_zum_entwickeln_und_konstruieren_technischer_systeme_und_produkte/ [Accessed 17 June 2016].

VESELY, D. 2004. *Architecture in the age of divided representation: the question of creativity in the shadow of production,* Cambridge MA, MIT press.

VIDLER, A. 1977. The third typology. *Oppositions,* 7**,** 288-294.

VINCENTI, W. G. 1990. *What engineers know and how they know it,* Baltimore, Johns Hopkins University Press.

VISSER, W. 2006. *The cognitive artifacts of designing*, Lawrence Erlbaum Associates.

VITRUVIUS POLLIO, M. & GRANGER, F. 1983. *On architecture,* Cambridge MA, Harvard University Press.

VITRUVIUS 1960. *Ten books on architecture,* New York, Dover.

VON MEISS, P. 2013. *Elements of architecture: from form to place,* Oxford, Routledge.

VOWLES, H., LOW, J. & DORON, H. R. 2012. Investigating Architecture Studio Culture in the UK. *Journal for Education in the Built Environment,* 7**,** 26-49.

WAKS, L. J. 2001. Donald Schon's philosophy of design and design education. *International Journal of Technology and Design Education,* 11**,** 37-51.

WALDMAN, P. 1982. A Primer of Easy Pieces: Teaching through Typological Narrative. *Journal of Architectural Education,* 35**,** 10-13.

WANG, T. 2010. A new paradigm for design studio education. *International Journal of Art & Design Education,* 29**,** 173-183.

WATTS, R. D. 1966. The elements of design. *The design method.* Springer.

WEBSTER, H. 2008. Architectural Education after Schön: Cracks, Blurs, Boundaries and Beyond. *Journal for Education in the Built Environment,* 3**,** 63-74.

WEXLER, M. N. 2009. Exploring the moral dimension of wicked problems*. *International Journal of Sociology and Social Policy,* 29**,** 531-542.

WHYTE, J. 2007. evolutionary theories and design practices. *design Issues,* 23.

WICKSTRÖM, G. & BENDIX, T. 2000. The" Hawthorne effect"—what did the original Hawthorne studies actually show? *Scandinavian journal of work, environment & health***,** 363-367.

WILLIAMS, J. 2014. The design studio as liminal space. *Charrette,* 1**,** 61-71.

WILLIAMS, T. & SCOFIDIO, R. 1982. Typology and Primary Elements. *Journal of Architectural Education,* 35**,** 8-9.

WILSON, J. O., ROSEN, D., NELSON, B. A. & YEN, J. 2010. The effects of biological examples in idea generation. *Design Studies,* 31**,** 169-186.

WOOLLEY, R. N. & PIDD, M. 1981. Problem Structuring -- A Literature Review. *The Journal of the Operational Research Society,* 32**,** 197-206.

WRIGHT, A. 2011. Critical Method: A pedagogy for design education. *Design Principles and Practices,* 5**,** 109-122.

WU, Y.-W. & WENG, K.-H. 2012. Using an analogical thinking model as an instructional tool to improve student cognitive ability in architecture design learning process. *International Journal of Technology and Design Education,* 23**,** 1017-1035.

WYLANT, B. 2010. Design Thinking and the Question of Modernity. *Design Journal,* 13**,** 217-231.

YILDIRIM, T., YAVUZ, A. O. & KIRCI, N. 2012. Experience of Traditional Teaching Methods in Architectural Design Education: “Mimesis Technique”. *Procedia - Social and Behavioral Sciences,* 51**,** 234-238.

YORKE, F. R. S. & GIBBERD, F. 1937. *The modern flat,* London, Architectural Press.

YUKHINA, E. 2007. *Cognitive Abilities & Learning Styles in Design Processes and Judgements of Architecture Students.* The University of Sydney.

YÜREKLI, A. 2013. The six-category intervention analysis: a classroom observation reference. *ELT Journal,* 67**,** 302-312.